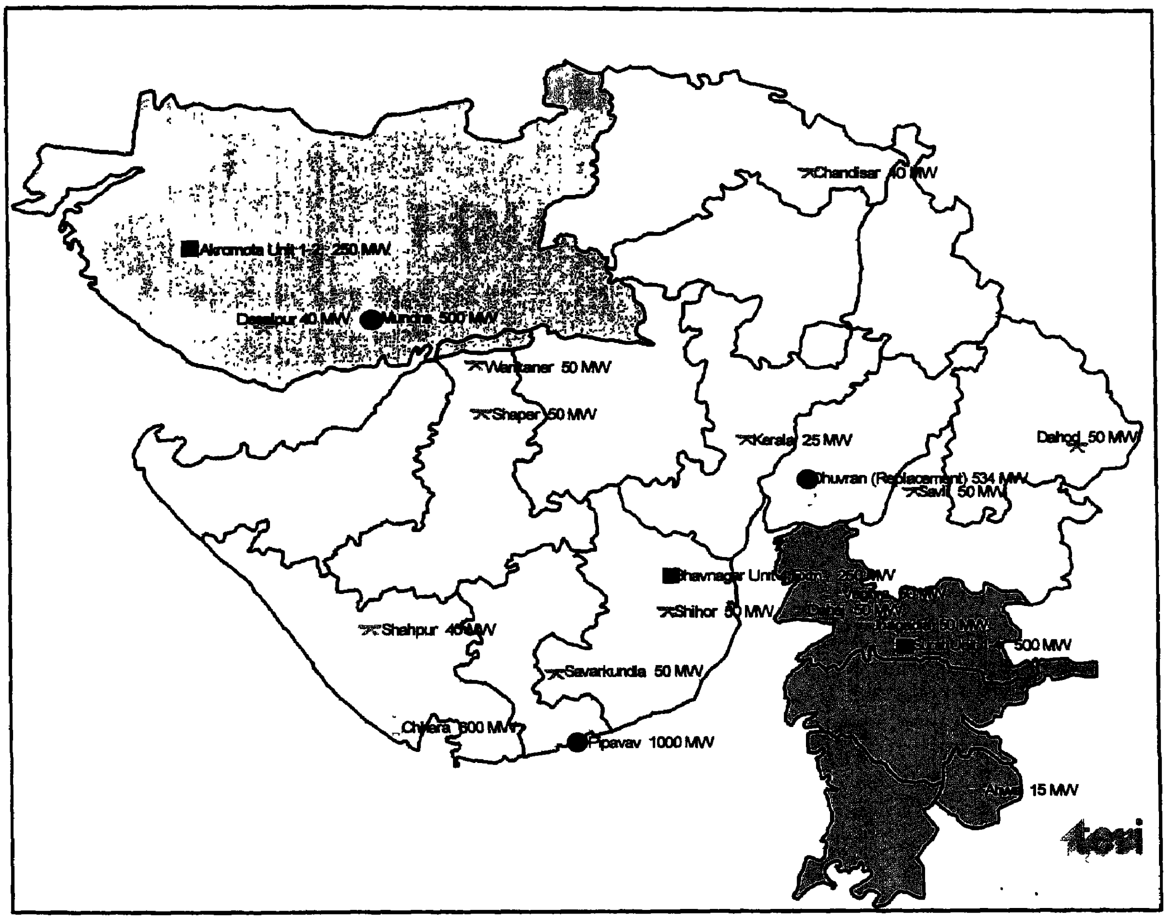
POWER SYSTEM MASTER PLAN FOR GUJARAT (1997-2012)

Submitted to
GUJARAT POWER CORPORATION LIMITED
AHMEDABAD



By

TATA ENERGY RESEARCH INSTITUTE
HABITAT PLACE, LODHI ROAD
NEW DELHI

JANUARY, 1998

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FINAL REPORT

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Executive Summary

Introduction

Gujarat is one of the most highly industralised states in the country. Gujarat is also recognised as one of the more efficient and professionally managed states in terms of financial and economic growth. In the post liberalisation era, the pace of industrial and economic growth has accelerated even further, with the result that the power supply industry is unable to cope with the increasing demands for electricity by various sectors of the state's economy. One of the basic reasons for this state of affairs is that he state power supply industry has been facing serious financial crunch mainly because of its helplessness in adjusting its power tariff to meet the higher expenses of fuel and other inputs on the one hand and the sharp escalation in the costs of power generation and supply equipment on the other. It is against this background that the Gujarat authorities decided to have a long term power system expansion plan study carried out by TERI with a view to framing a suitable strategy for power sector growth in the state covering a 15 year time period 1997-2012.

Objective

The objective of the study for evolving a power system master plan for Gujarat is basically to assist the state government to formulate a realistic power development strategy to meet the growing electricity demands of the different sectors of the state's economy over the next 15 years. In order to evolve a long-term perspective of the power development scenario the exercise covers detailed studies of the following aspects which would determine the appropriate planning strategy to be adopted :

- Past trends in growth of power demands by consumer sector-wise
- Assessment of future demands - in terms of energy and peaking demand
- Status regarding availability of energy resources and strategy for developing an optimal generation capacity expansion program keeping in view relevant factors like transport, electricity transmission costs etc.
- Transmission system augmentation program to match the capacity addition program
- Issues regarding environmental impact, ash disposal, water availability etc. associated with thermal capacity addition
- Allied issues like reduction of T&D losses, distribution system automation, demand side management
- Fund requirements for proposed power program and possible modes of funding and investment pattern.

Methodology

For power planning, two approaches are available. Power planning can be done by adopting deterministic approach or more sophisticated probablistic techniques. Effectiveness of probablistic approach for planning purposes depends entirely on availability of extensive past statistical data of the various power system elements in regard to their performance, reliability, etc. over a number of years which are not readily available for most power systems in India. Further, in view of the heavy power deficits being faced by the western region (including Gujarat), some short term solutions have to be found to alleviate the shortages which would have to be determined based more on expediency and judgement rather than from mere theoretical considerations. In view of these considerations, the present planning studies have been based on deterministic approach.

In the context of uneven dispersal of energy resources in the country as well as the existence of central government owned regional super-thermal power stations in which Gujarat has a share, the planning studies recognize the inadequacies of state as a planning unit. In the studies the spatial limit has been extended beyond, the state limits to the Western Region and even beyond for the purpose of assessing availability of energy resources like coal, oil, gas, hydro etc.

Energy and Demand Forecast

The energy demand forecasting was done using four broad customer classifications, viz Industrial, Commercial, Domestic and Agriculture. Both LT and HT industrial sectors were covered under the category "Industrial", while public lighting, railway traction and miscellaneous sales, besides commercial, were covered under the "Commercial" category. Historical electricity sales data for Gujarat from 1980/81 to 1993/94 as available in the General Review published by the Central Electricity Authority, New Delhi, and the information/data furnished by GEB/PGCL was used to establish the general growth trends in the individual sectors.

Further, based on the above, the energy requirement for the state (utilities and non-utilities) has been worked out. The compounded annual rate of growth (CARG) for the total energy requirement works out to around 8% in the 9th and 10th plan which declines to about 6.5% in the 11th plan. The anticipated energy required and (peak demand) for Gujarat works out to 53,781 Mkwh. (9522 MW) at the end of 9th plan. The anticipated energy required and (peak demand) would be 86,286 Mkwh (13,873) and 118,473 Mkwh (19,048 MW) corresponding to 10th and 11th plan periods respectively.

Generation planning

Gujarat stat is not well endowed with conventional resources for power production and so far the generation planning for Gujarat has been mainly based on coal although Gujarat has no coal resources of its own. As regards hydel power there are no storage hydro reservoirs in the state. However, Gujarat has oil and natural gas resources in its southern part. The state has also lignite resources spread over four locations.

While planning the future generation pattern for Gujarat, the relative economics of generation per unit of electricity corresponding to different fuel resources available/likely to be available have been taken into consideration. It would be seen that pithead generation based on local lignite resources works out to be most economical and load centre generation from imported coal based power station is the costliest. While planning the generation programme the use of non-conventional energy sources has also been made use of. However, the energy available from these sources cannot be relied upon for meeting the peak demand.

Based on analysis of relative economics of the cost of generation, it would be preferable to assign the highest merit order to the gas based combined cycle plant, to be operated at the highest possible PLF to realise maximum possible advantage of this mode of generation. If necessary two shift operations may have to be resorted to in respect of old thermal units. The anticipated installed capacity of Power Plants in Gujarat at the end of 8th Plan (1992-97) is expected to be 7157 MW (Actual installed capacity achieved during 8th plan was 6667 MW) comprising of (coal 3954 MW, lignite 215 MW, gas 1148 MW and central sector share as 1293 MW). The present peak demand (restricted) is 5225 MW. The unrestricted demand is of the order of 6883 MW indicating a shortage of 1658 MW in the system. The first objective is therefore, to mitigate the shortage as early as possible. For this purpose, it is necessary to expedite work on the following short gestation projects.

i)	Paguthan (Gandhar)	655 MW	New IPP GT station
ii)	Hazira	160 MW	New IPP GT station
iii)	Ahmedabad	150 MW	Naphtha Extension at existing station
iv)	Ahmedabad	120 MW	Gas Extension at existing station
v)	Pipavav	655 MW	New IPP GT station
vi)	Jamnagar	500 MW	New station at refinery
		2240 MW	

Simultaneously with the above it is necessary that work is started on the 600 MW-IC Small Size (Heavy Oil) sets to be used as peaking units at various grid substations. These works will hopefully ensure that there is no power shortage by July 1998. Further the work on 210 MW coal based extension projects at Gandhinagar and Wanakbori should be expedited so as to complete these units in 3-3½ years. New Lignite Projects have been proposed at Ghoga (Bhavnagar), Mongrol and Akrimota. Work is required to be started on these projects during 1997-98 to ensure commissioning of the first unit at these station during 2001.

Moreover Gujarat has to depend to a large extent on outside resources for power development. Long term contracts have therefore to be concluded with MPEB, OSEB for import of power and suitable arrangements made for infrastructure development.

Further arrangements have to be made for creation of LNG import facilities at Chhara-Sakhardi port.

Depending on the outcome of the various policies introduced at the end of 8th Plan, a mid-term review of the proposed program will be required to finalise the work during the 11th Plan. In nutshell anticipated fuelwise Capacity of plants, as on March 1997 and at the end of 11th plan is indicated in the table below:

Fuel Type	As on March 97 (MW)	As on March, 2012 (MW)	Net addition during three plants (MW)	
Coal	3954	6384	2430	
Lignite	215	2590	2375	
Gas	1148	6317	5169	
Naphtha/Heavy Oil	0	1980	1980	
Share from common projects	1293	2205	912	
Import	-	3980	3980	
Other	547	2047	1500	Includes Hydro and Non-Conventional
Total	7157*	25503	18346	

* actual installed capacity by 31.3.97 was 6667 MW (see Table 1c page 12)

It would be seen that the maximum addition to the capacity is by gas which happens to be cheapest. Coal and lignite are the next. The imported power capacity is also mainly coal based.

Transmission planning

The transmission system for evacuation of power from generating stations likely to be commissioned during the various plan periods and transmitting the power to various load centres of the state has been developed generally in accordance with CEA guidelines and planning philosophy issued in June 1994. The relative extracts from the guidelines issued by CEA are enclosed as Annexures after Chapter 3. Power flow studies have been carried out to ensure that the recommended transmission system has the necessary power evacuation capacity within permissible voltage regulations, line loadings, power loss and line outages. The transmission network so planned will be over laid on the existing network and will be so phased that it provides a minimum of redundancy of one line (n-1) outage in case of 400 kV system and double circuit line (n-2) outage in case of 220 kV system while meeting the full power evacuation requirements. As the transmission system development is an evolutionary process it has to be ensured that the system development in the intermediate time frames also take place without causing premature redundancies in the ultimate time frame. This has been achieved by planning the ultimate network first and then work backward to arrive at the system expansion plans in the intermediate time frame taking into account the present status of the system. For the purpose of transmission planning studies, the generation despatch schedules corresponding to possible system operating conditions for testing the adequacy of transmission system evolved in the studies had been prepared. The norms for planned outages for generating units as recommended in CEA's manual on transmission planning criteria-June 1994 have been adopted. For determining the evacuation system for a new generating project, maximum possible generation from the concerned generation pocket have been considered to test system performance under extreme conditions of operation. The transmission network at 220 kV and 400 kV has been fully represented in the studies. Further all the 132 kV lines required for evacuation of power from major power stations has also been representated in the studies. Based on the power system studies carried out for the various generation scenarios additional transmission system required for system strengthening has also been planned.

Keeping in mind the above considerations, the additional transmission network required at 220 kV above during the period 1996-2012 is indicated below:

Transmission system	Additional transmission network required during		
	1996-02 kms	2002-07 kms	2007-12 kms
400 kV D/C lines	499	525	135
400 kV S/C lines	119	-	65
220 kV D/C lines	1163	166	72
220 kV S/C lines	248	-	-
Stringing of 2nd ckt	-	360	-

Reduction of T&D losses

There is a world wide concern at the rapidly diminishing sources of energy which had led to the realisation of the need to develop the renewable sources of energy as well as the necessity to minimise wasteful use of energy. In this context, the present T&D loss figure for the state of Gujarat is 19% which is lower than the national average of about 22%. Still it will be necessary to reduce these losses to the minimum possible. The main factors considered to be responsible for the high T&D losses in Gujarat power system would be broadly classified into three categories i.e. financial, administrative and technical. In the report various short term and long term measures have been suggested for reducing the T&D losses.

Distribution automation and Demand Side Management

As per the terms of reference it has been suggested to go in for automation in the monitoring, control and production of distribution system. Based on the status of distribution automation in the state, a scheme for implementation of Distribution Automation scheme has been suggested. A study of typical load curves of GEB system indicates that there is considerable difference between the system demands recorded during the peak and off-peak periods in the daily load cycle in all the three seasons of the year. Some of the DSM options that could be considered for implementation in the Gujarat system under various categories of load has been suggested.

Financial

Based on the 1994-95 level of prices the fund requirements for the proposed expansion plan for Gujarat during 9th, 10th and 11th plan period has been worked out. These fund requirements are based on normative requirements both for generation and transmission and distribution works. Presently, Gujarat like all other states in India is facing acute resource constraints for financing all the sectors in their economy. Although allocations for

the power sector have been comparatively reasonable in view of its importance in development of other key allied sectors like industry, agriculture etc. these allocations have normally fallen short of the requirement. It is in this context that it is felt that full advantage should be taken of the present liberalisation policy of the government in so far as the induction of private entrepreneurs in the power sector of the country is concerned. The various assumptions regarding investment by private power participation in the generation as well as transmission and distribution works is based on the considerations that private sector participation will be available.

Conclusions

In order to meet the project load demand during the various plans, it has been proposed to increase the generation capacity by 5027 MW during 9th plan, 6764 MW during 10th plan and 8250 MW during 11th plan. For evacuation of this power and to transmit the same to various load centres in the state, it has been proposed to increase the transmission network at 400 kV by 2502 circuit kms. and at 220 kV by 3050 circuit kms. during the three plan periods. For implementation of this programme, the fund requirement based on various assumptions works out to Rs.31162 crores, 35812 crores & 51954 crores during 9th, 10th & 11th plan respectively. Out of this the utility outlay works out to Rs.6653 crores, 8411 crores and 10520 crores corresponding to 9th, 10th & 11th plan periods. The balance amount is proposed to be available from Independent Power Producers.

Note

During discussions held with GEB/GIPCL authorities in November, 1997 at Vadodra, it was intimated that the data pertaining to generation and transmission scenario furnished by GEB/GPCL for March 1996 conditions had undergone changes during the period April, 1996 to July 1997. While as per the Terms of Reference it was not possible for TERI to redo the whole studies, it was agreed that a copy of power system studies carried out by Gujarat Electricity Board corresponding to 1997-98 and 2001-02 conditions as supplied by GEB during discussions, would be enclosed as Appendices to the report. The same has, therefore, been added as Appendix- Z.

CHAPTER 1

Electric power system master plan for Gujarat (1997-2012)

Background, Objective & Methodology

1.1 Background

Gujarat is one of the most highly industrialized states in the country. The per capita consumption of electricity in the state in 1995/96 has been 650 units which is higher than that of the neighboring state of Maharashtra as well as the national average of 345 units. Gujarat is considered to be one of the better managed states in terms of financial and economic growth. In the post-liberalization era the pace of industrial and economic growth has accelerated even further, with the result that the power supply industry is unable to cope with the increasing demands for electricity by the various sectors of the state's economy. One of the basic reasons for this state of affairs is that the state power supply industry has been facing serious financial crunch mainly because of its helplessness in adjusting its power tariff to meet the higher expenses of fuel and other inputs on the one hand and the sharp escalation in costs of power generation & supply equipment on the other. In other words raising adequate financial resources for necessary augmentations in the power supply facilities in a resource-constrained economy and long gestation period involved in creation of power supply facilities as well as the changing social values are some of the factors that have subjected the power supply industry in Gujarat to severe pressures. It is against this background that the Gujarat authorities decided to have a long-term power system expansion plan study carried out by TERI with a view to framing a suitable strategy for power sector growth in the state covering a time horizon from 1996-97 (end of 8th plan) to 2011-12 (end of 11th plan) vide Gujarat Power Corporation letter No.GPCL/TECH/PSMP/356:7618 dated 26.6.1996.

In this context it would not be out of place to point out that while there are a number of advantages of drawing up a long-term perspective plan the result of these studies suffer from certain limitations. Although these studies no doubt endeavor to present a reasonably realistic picture of the likely course of future development, however, in view of the very large number of imponderable factors involved in the exercise, which in turn are affected by various socio-political, economic and technical parameters obtaining at different points of time in the future, the results of the long term perspective plan studies might undergo unforeseen and significant modifications over a period of time. Thus, the preparation of a long-term master plan should not be considered as a one time study and has necessarily to be updated from time to time taking into consideration the various changed economic, political and social scenarios

at different points of time.

1.2 Objective

The objective of the study for evolving a power system master plan for Gujarat is basically to assist the state government to formulate a realistic power development strategy to meet the growing electricity demands of the different sectors of the state's economy over the next 15 years. In order to evolve a long-term perspective of the power development scenario the exercise covers detailed studies of the following aspects which would determine the appropriate planning strategy to be adopted:

- Past trends in growth of power demands by consumer sector-wise
- Assessment of future demands - in terms of energy and peaking demand
- Status regarding availability of energy resources and strategy for developing an optimal generation capacity expansion program keeping in view relevant factors like transport, electricity transmission costs etc.
- Transmission system augmentation program to match the capacity addition program
- Issues regarding environmental impact, ash disposal, water availability etc. associated with thermal capacity addition
- Allied issues like reduction of T&D losses, distribution system automation, demand side management
- Fund requirements for proposed power program and possible modes of funding and investment pattern.

1.3 Methodology

For power planning two approaches are available. Power planning can be done by adopting deterministic approach or more sophisticated probablistic techniques. Effectiveness of probablistic approach for planning purposes depends entirely on availability of extensive past statistical data of the various power system elements in regard to their performance, reliability, etc. over a number of years which are not readily available for most power systems in India. Further, in view of the heavy power deficits being faced by the western region (including Gujarat), some short term solutions have to be found to alleviate the shortages which would have to be determined based more on expediency and judgement rather than from mere theoretical considerations. In view of these considerations, the present planning studies have been based on deterministic approach.

For the planning studies to be carried out in subsequent years for updating and revising the results of the present studies in regard to 10th & 11th plan programs, it might be possible to adopt the probabilistic approach for planning as it is likely that by that time required reliable statistical data would become available both in respect of generation and transmission.

In the context of uneven dispersal of energy resources in the country as well as the existence of central government owned regional super-thermal power stations in which Gujarat has a share, the planning studies recognize the inadequacies of state as a planning unit. In the studies the spatial limit has been extended beyond, the state limits to the Western Region and even beyond for the purpose of assessing availability of energy resources like coal, oil, gas, etc.

CHAPTER 2

Energy and Demand Forecasts

2.1 Introduction

In order to carry out the generation and transmission and distribution planning for the future, the first requirement is a reliable forecast of electricity demand and energy requirements.

The forecasting was done using four broad customer classifications, viz. Industrial, Commercial, Domestic and Agriculture. Both LT and HT industrial sectors were covered under the category "Industrial", while public lighting, railway traction and miscellaneous sales, besides commercial, were covered under the "Commercial" category.

Historical sales data for Gujarat from 1980/81 to 1993/94 as available in the General Review published by the Central Electricity Authority, New Delhi, was used to establish the general growth trends in the individual sectors. The General Reviews of various years and the information furnished by GPCL/GEB were also the source of information for data regarding captive generation in Gujarat.

2.2 Industrial sector

Captive generation accounts for a major share of the total electricity generation in Gujarat Industries. Though a small amount of the electricity generated by captive plants may have been sold to the Gujarat Electricity Board, for the purpose of forecasting, this sale, if any, has been assumed to be negligible, and the entire generation deemed to have been consumed by the industries owning the captive plants.

Keeping this assumption in mind, the total energy consumed by the industrial sector in any year was taken as the sum of energy sold to the sector by GEB and the energy generated by captive plants.

The total energy consumption by the industrial sector was regressed against the value added by the mining and manufacturing sectors to the State Domestic Product (SDP) in any year, to arrive at a relationship between the contribution of the industrial sector to the SDP and energy consumption in the sector.

The growth rate of the industrial sector's contribution to the SDP has been assumed to be around 8-10% during the three plan periods under consideration.

Captive generation has historically played an important role in Gujarat, and is expected to do so in the future also, its growth being assumed at 3% from 1996-97 to 1997-98, and then the climbing to 6.5% from 1998-99 to 2001-02 as clearances to more captive plants are given in order to augment the supply from GEB. Thereafter, as the utility and IPP owned generation plants start coming on stream, the rate of growth of captive generation is expected to drop to 3% again between 2002-03 to 2011-12.

2.3 Commercial

The methodology followed for forecasting the energy requirements of the commercial sector was essentially the same as that for the industrial sector. The contributors to the SDP, which were taken to comprise the commercial sector were Electricity, Gas and Water Supply; Transport by Railways; Storage; Trade, Hotels and Restaurants; Banking and Insurance; Real Estate; Public Administration; and Others.

The combined value addition to the SDP by the various contributors mentioned above, was taken to grow at a rate of around 8.5% during the IX plan, and thereafter show a slight declining trend for the X Plan and XI Plan, being 8.25% and 7.50% respectively.

Keeping the value addition to the SDP as the independent variable, and the energy consumption in the commercial sector as the dependent variable, a linear regression was carried out to determine the relationship between the two. Once the relationship was determined, the corresponding values for commercial sector's contribution to the SDP, as determined in the preceding paragraph, were used to calculate the expected energy requirement in the commercial sector in any given year.

2.4 Domestic

The domestic sector is a difficult sector to forecast as the energy consumption in the sector can not be readily correlated with any of the standard indices. An attempt was made to use the state's population as an index for energy consumption in the domestic sector, but this approach was discarded as the average growth rate of energy requirement was coming as very low. It was felt that since the energy intensity in the domestic sector was showing a rapid increase with the introduction of household gadgets, the regression was unable to capture this factor.

The Compounded Annual Rate of Growth (CARG) for the domestic sector was found to be 11%, and it was decided to use this same rate of growth in the sector the future.

2.5 Agriculture

Forecasting of the agricultural load for Gujarat was done wholly on the basis of the data supplied by the project sponsors. The sponsors had indicated an irrigation pumpset energisation program from 1996-97 to 2005-06.

Using the data supplied, it was calculated that on an average, one pumpset is rated at 8 kW, and operates for 2100 hours annually. This would mean that one pumpset places a load of 16.80 thousand units per year on the system. The number of pumpsets to be energized in a year was multiplied by 16,800 kWh to get the additional energy requirement in the agriculture sector for that year.

It must be mentioned that the Rural Electrification Corporation through its letter no. 2401/53 dated 25-12-95 has indicated that the maximum number of pumpsets which can be supported in Gujarat is about seven lakhs, while the pumpsets energisation program would bring the total number of pumpsets to a little more than ten lakhs by 2005-06.

2.6 Estimation of energy requirement at consumer end

Based on the norms indicated in the previous paragraphs, the energy requirement for state (utilities and non-utilities) under various plan period was worked out and is indicated in Table 1 below. The compounded annual rate of growth (CARG) for the total energy requirement works out to be around 8% in the IX and X plans, and declining to about 6.5% in the XI plan.

Table 1. Category-wise Anticipated Energy requirement at consumer end from 1996-97 to 2011-12 (M kWh)

Year	Industrial	Commercial, Misc, Others	Domestic	Agriculture	Total (MkWh)	Population ('000)	Per capita kWh consumption
1996-97	15,963	2678	4535	10,924	34,129	44,166	773
1997-98	16,663	2798	4718	11,690	35,869	44,701	802
1998-99	17,044	2946	5076	12,757	37,823	45,223	836
1999-00	19228	3271	5630	13,824	41,953	45,770	917
2000-01	21674	3626	6245	14,328	45,874	46,318	990
2001-02	24414	4016	6927	14,832	50,189	46,855	1,076
2002-03	26971	4386	7684	15,336	54,378	47,495	1,145
2003-04	29784	4787	8524	15,840	58,935	48,112	1,225
2004-05	32878	5221	9455	16,344	63,898	48,737	1,311
2005-06	36281	5691	10487	16,848	69,308	49,371	1,404
2006-07	40025	6200	11633	16,848	74,706	50,013	1,494
2007-08	43320	6700	12904	16,848	79,772	50,663	1,575
2008-09	46878	7238	14313	16,848	85,278	51,322	1,662
2009-10	50721	7817	15877	16,848	91,262	51,989	1,755
2010-11	54871	8439	17611	16,848	97,769	52,665	1,856
2011-12	59353	9107	19535	16,848	10,4843	53,349	1,965

2.6.1 Estimation of the peak demand and installed capacity for the state

Once the total energy required to be generated was arrived at after taking T&D losses into account, the peak demand was estimated by assuming a system load factor (SLF) of 0.71. A 27% reserve margin was added to the peak demand for purposes of calculating the installed capacity requirements. As per the data furnished by GPCL/GEB, the average annual reserve margin for peaking capability is 25%. Further average annual plant load factor for Gujarat is about 68%. As per standard norms the peaking capability from the installed capacity could be worked out by taking peaking capability factor 5 percentage more than the average plant load factor (PLF) i.e. 73%. Taking these points in view a conservative estimate of 73% has been taken to work out installed capacity from peak demand requirement. Table 1 below gives the forecast of sector-wise energy requirement at consumer end.

2.6.2 Estimation of Energy requirement and peak demand to be met by captive power plants

After estimating the energy and peak demand requirement of the state; the energy requirement of captive power plant was worked out based on the actual generation from the existing captive power plants as per information furnished by GPCL/GEB and assuming a constant annual growth rate of energy from captive power plants as 6% during the ninth plan period. However the growth rate of energy requirement from captive power plants during Tenth (2002-07) and Eleventh Plan (2007-12) have been assumed as 3% as benefits from additional generation capacity from utilities is expected to be available and peak period shortage would be reduced. The following Table 2 indicates the anticipation energy generation and peak demand served by captive power plants.

Table 2. Anticipated energy generated and peak demand served by Captive power plants

Year	Energy generation (MkWh)	Peak demand served (MW)
2001-02	5443	875
2006-07	6310	1015
2011-12	7315	1176

2.7 Zone-wise energy requirement

The shares of the various zones in the total energy requirement for the state in different years was estimated based on the information furnished by GPCL/GEB and as per the discussions held with the sponsors of the project. Table 3 on the next page gives the forecast of zone-wise energy and peak demand requirement for utilities only.

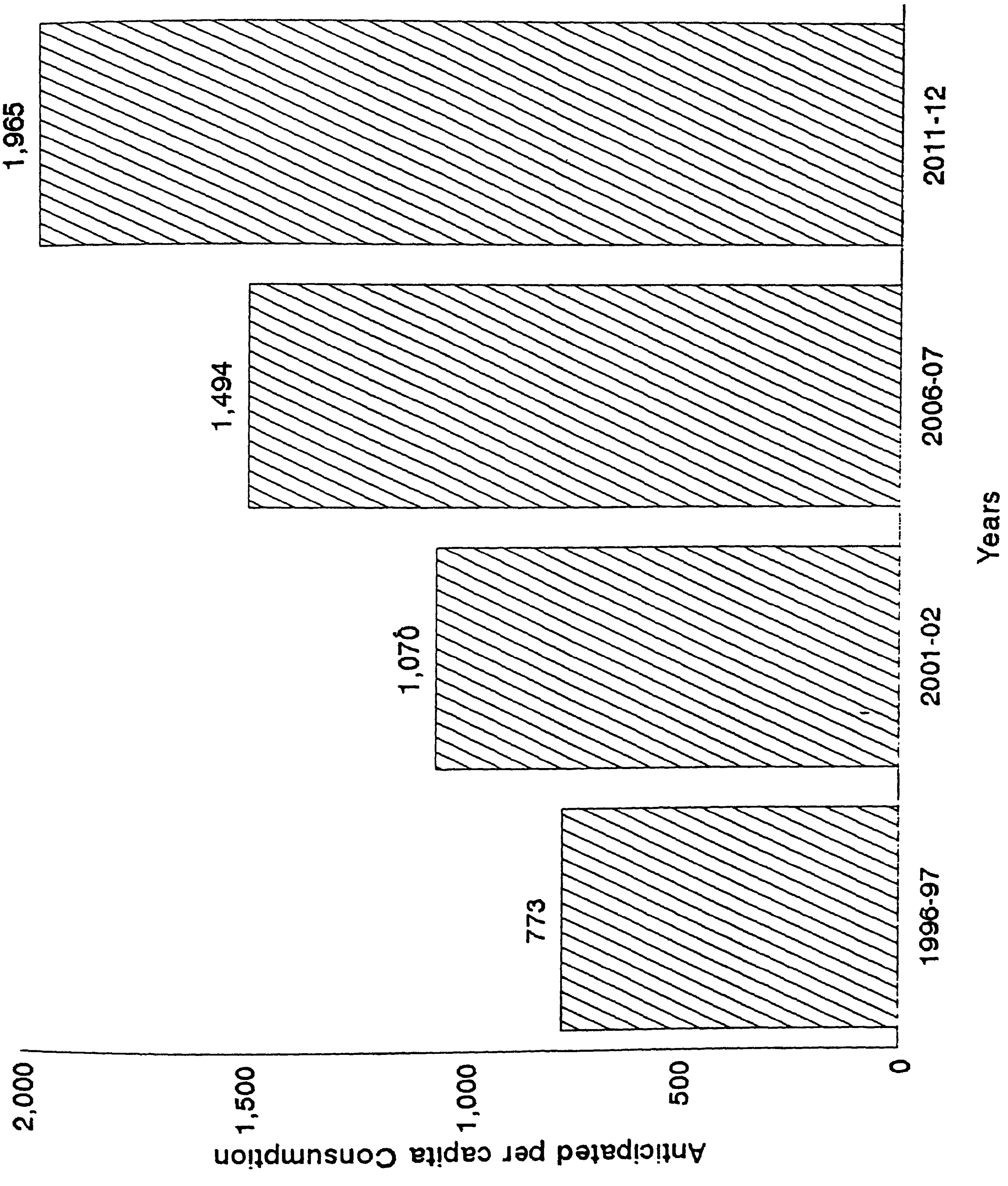
Anticipated per capita Consumption
2,000
1,500
1,000
500
0
773
1,070
1,494
1,965
1996-97
2001-02
2006-07
2011-12
Years

Table 3. Zone-wise Anticipated peak demand and energy required at the generation bus (utilities only)

Year	South			Central			North			Saurashtra			Kutch			Total	
	%	MkWh	MW	%	MkWh	MW	%	MkWh	MW	%	MkWh	MW	%	MkWh	MW	MkWh	MW
1996-97	24.00	8,759	1,408	30.00	10,949	1,760	24.00	8,759	1,408	20.00	7,299	1,174	2.00	730	117	36,495	5,868
1997-98	24.20	9,288	1,493	29.60	11,361	1,827	23.80	9,135	1,469	20.20	7,753	1,247	2.20	844	136	38,382	6,171
1998-99	24.40	9,851	1,584	29.20	11,788	1,895	23.60	9,528	1,532	20.40	8,236	1,324	2.40	969	156	40,371	6,491
1999-00	24.60	11,039	1,775	28.80	12,924	2,078	23.40	10,500	1,688	20.60	9,244	1,486	2.60	1,167	188	44,874	7,215
2000-01	24.80	12,174	1,957	28.40	13,941	2,242	23.20	11,389	1,831	20.80	10,211	1,642	2.80	1,375	221	49,090	7,893
2001-02	25.00	13,445	2,162	28.00	15,059	2,421	23.00	12,370	1,989	21.00	11,294	1,816	3.00	1,613	259	53,781	8,647
2002-03	25.20	14,688	2,362	27.60	16,087	2,587	22.80	13,290	2,137	21.20	12,357	1,987	3.20	1,865	300	58,288	9,372
2003-04	25.40	16,063	2,583	27.20	17,201	2,766	22.60	14,292	2,298	21.40	13,533	2,176	3.40	2,150	346	63,238	10,168
2004-05	25.60	17,543	2,821	26.80	18,365	2,953	22.40	15,350	2,468	21.60	14,802	2,380	3.60	2,467	397	68,526	11,018
2005-06	25.80	19,162	3,081	26.40	19,608	3,153	22.20	16,488	2,651	21.80	16,191	2,603	3.80	2,822	454	74,271	11,942
2006-07	26.00	20,794	3,343	26.00	20,794	3,343	22.00	17,595	2,829	22.00	17,595	2,829	4.00	3,199	514	79,976	12,859
2007-08	26.20	22,385	3,599	25.60	21,872	3,517	21.80	18,626	2,995	22.20	18,967	3,050	4.20	3,588	577	85,438	13,737
2008-09	26.40	23,977	3,855	25.20	22,887	3,680	21.60	19,617	3,154	22.40	20,344	3,271	4.40	3,996	643	90,821	14,602
2009-10	26.60	25,840	4,155	24.80	24,092	3,874	21.40	20,789	3,342	22.60	21,955	3,530	4.60	4,469	718	97,144	15,619
2010-11	26.80	27,836	4,476	24.40	25,343	4,075	21.20	22,020	3,540	22.80	23,681	3,808	4.80	4,986	802	103,866	16,700
2011-12	27.00	30,013	4,826	24.00	26,678	4,289	21.00	23,343	3,753	23.00	25,566	4,111	5.00	5,558	894	111,158	17,872

Table 3. Zone-wise Anticipated peak demand and energy required at the generation bus (utilities only)

Year	South			Central			North			Saurashtra			Kutch			Total	
	%	MkWh	MW	%	MkWh	MW	%	MkWh	MW	%	MkWh	MW	%	MkWh	MW	MkWh	MW
1996-97	24.00	8,759	1,408	30.00	10,949	1,760	24.00	8,759	1,408	20.00	7,299	1,174	2.00	730	117	36,495	5,868
1997-98	24.20	9,288	1,493	29.60	11,361	1,827	23.80	9,135	1,469	20.20	7,753	1,247	2.20	844	136	38,382	6,171
1998-99	24.40	9,851	1,584	29.20	11,788	1,895	23.60	9,528	1,532	20.40	8,236	1,324	2.40	969	156	40,371	6,491
1999-00	24.60	11,039	1,775	28.80	12,924	2,078	23.40	10,500	1,688	20.60	9,244	1,486	2.60	1,167	188	44,874	7,215
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2004-05	25.60	17,543	2,821	26.80	18,365	2,953	22.40	15,350	2,468	21.60	14,802	2,380	3.60	2,467	397	68,526	11,018
2005-06	25.80	19,162	3,081	26.40	19,608	3,153	22.20	16,488	2,651	21.80	16,191	2,603	3.80	2,822	454	74,271	11,942
2006-07	26.00	20,794	3,343	26.00	20,794	3,343	22.00	17,595	2,829	22.00	17,595	2,829	4.00	3,199	514	79,976	12,859
2007-08	26.20	22,385	3,599	25.60	21,872	3,517	21.80	18,626	2,995	22.20	18,967	3,050	4.20	3,588	577	85,438	13,737
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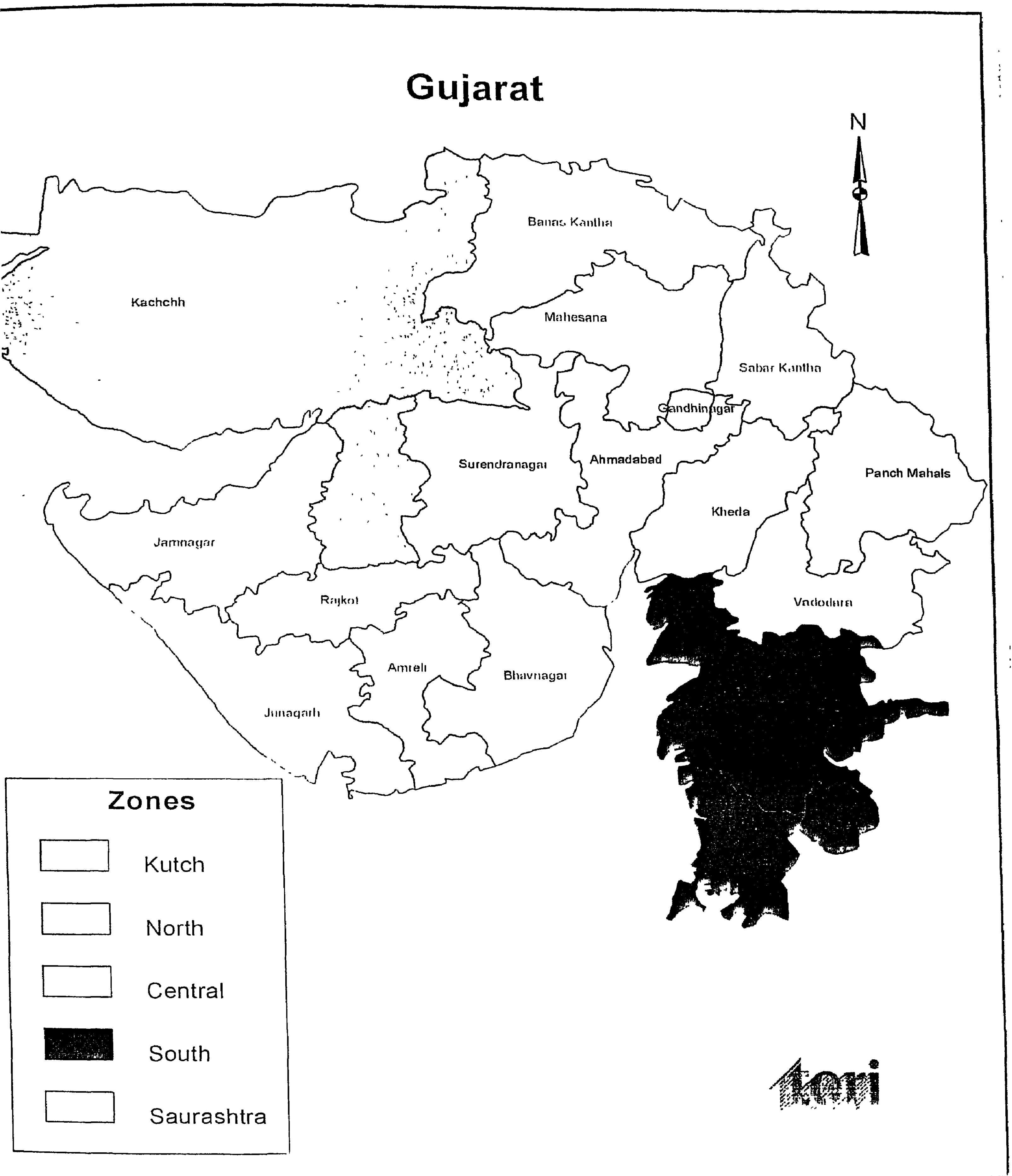
2009-10	26.60	25,840	4,155	24.80	24,092	3,874	21.40	20,789	3,342	22.60	21,955	3,530	4.60	4,469	718	97,144	15,619
2010-11	26.80	27,836	4,476	24.40	25,343	4,075	21.20	22,020	3,540	22.80	23,681	3,808	4.80	4,986	802	103,866	16,700
2011-12	27.00	30,013	4,826	24.00	26,678	4,289	21.00	23,343	3,753	23.00	25,566	4,111	5.00	5,558	894	111,158	17,872



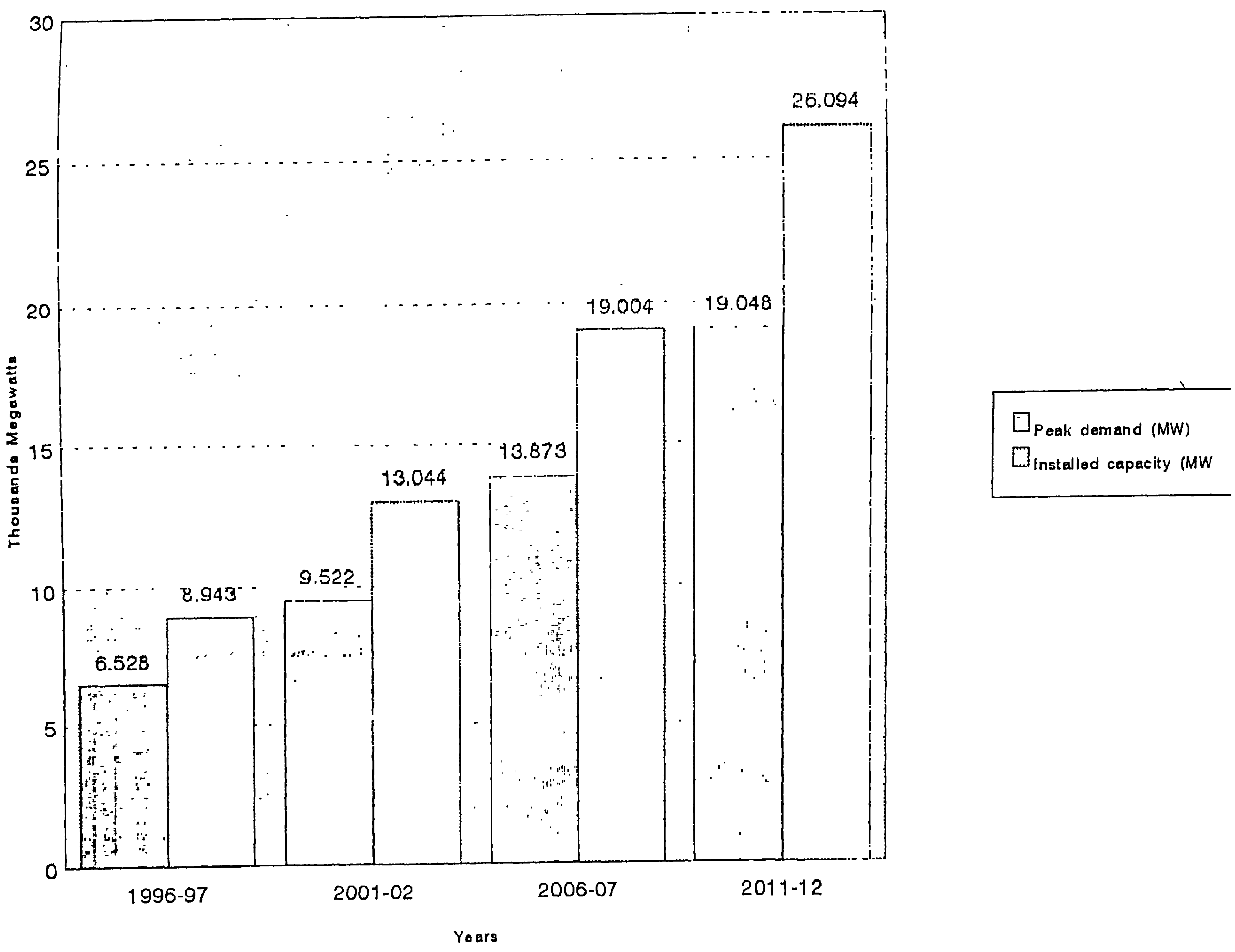
Zonal map of Gujarat

For the purpose of planning studies, the Gujarat state has been divided into five zones. The names of the zones and the name of the districts covered in each zone are as follows:

Zone wise districts

Sl No	Name of the zone	Name of districts covered
1	North Zone	1. Banaskantha (Palampur)
		2. Sabarkantha (Himmat nagar)
		3. Mehsana
2	Central Zone	1. Vadodra
		2. Panch Mahal (Godhra)
		3. Kheda
		4. Ahmedabad/Gandhinagar
3	South Zone	1. Valsad
		2. Surat
		3. Ahwa
		4. Bharuch
4	Saurashtra Zone	1. Surendera Nagar
		2. Jamnagar
		3. Junagadh
		4. Amreli
		5. Bhavnagar
		6. Southern part of Rajkot district
5	Kutch Zone	1. Bhuj
		2. North part of Rajkot district

The analysis of the zone-wise load demand for 1996-97, furnished by GPCL/GEB, indicated that the maximum concentration of load demand (about 30% of total load) was in the central zone, the load demand in North and South zones was 24% of the total load demand, the load demand in Saurashtra was 20% of the total demand and the load demand in Kutch area was only about 2% of the total demand. Taking these percentages as the base the percentage of zone-wise load demand to the total anticipated peak demand was uniformly increased by 3% over a period of 15 years in South, Saurashtra and Kutch zones and uniformly decreased by 3 percent during the three plans in the case of central and north zones of the state. The main reason for the proposed increase/decrease in load concentration was to avoid rapid development of load growth in already congested areas of central and north zones and increased development of load growth in the areas where concentration of load is not there. Table 3 gives the anticipated energy requirement zone-wise.


30
25
20
15
10
5
0
Thousands Megawatts
6.528
8.943
9.522
13.044
13.873
19.004
19.048
26.094
1996-97
2001-02
2006-07
2011-12
Years
☐ Peak demand (MW)
☐ Installed capacity (MW

2.7.1 The anticipated zone-wise energy requirements at the generation end for the Gujarat state as a whole from the year 1996-97 to 2011-12 has been worked out and is given in the Table-4.

Table 4. Anticipated Zone-wise Energy requirement at the generation bus (utilities & non-utilities) from 1996-97 to 2011-12

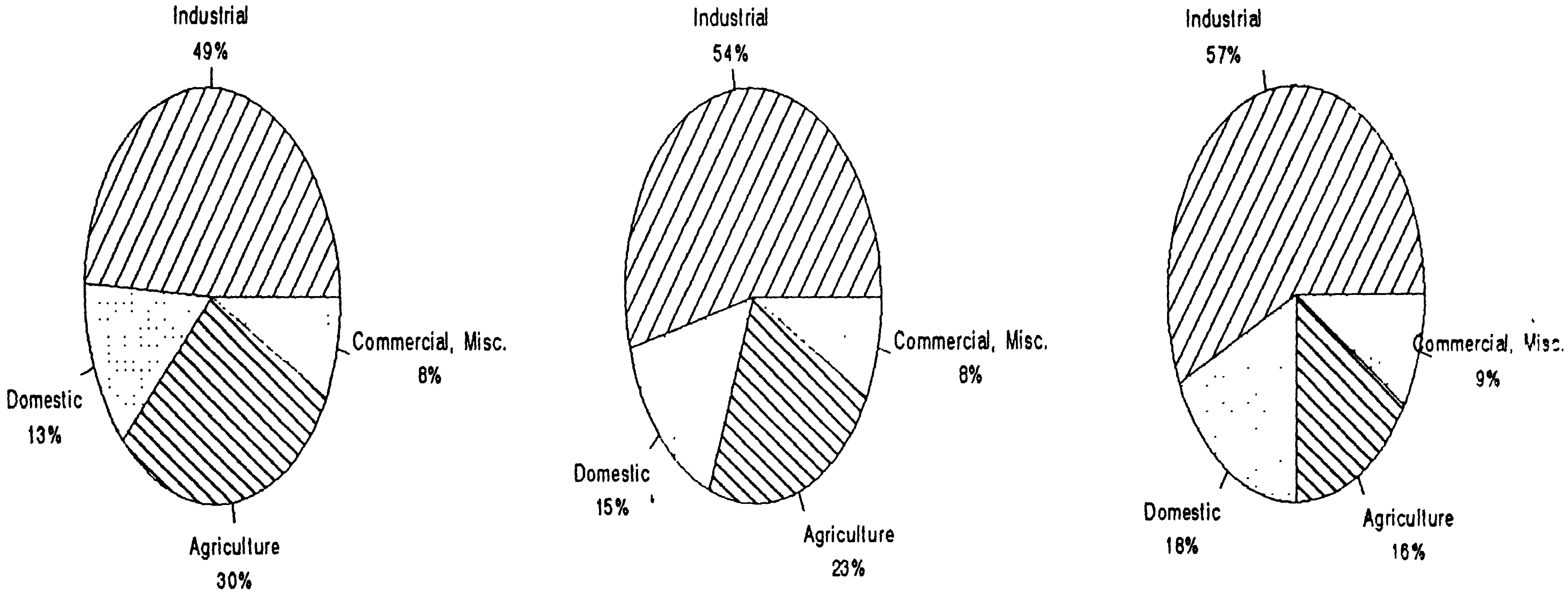
Million kWh

Year	Energy required at bus (MkWh)	South zone		Central zone		North zone		Saurashtra zone		Kutch zone	
1996-97	40603	24.00%	9745	30.00%	12181	24.00%	9745	20.00%	8121	2.00%	812
1997-98	42612	24.20%	10312	29.60%	12613	23.80%	10142	20.20%	8608	2.20%	937
1998-99	44877	24.60%	10950	29.20%	13104	23.60%	10591	20.40%	9155	2.40%	1077
1999-00	49672	24.80%	12219	28.80%	14306	23.40%	11623	20.60%	10233	2.60%	1291
2000-01	54200	25.00%	13442	28.40%	15393	23.20%	12574	20.80%	11274	2.80%	1518
2001-02	59224	25.20%	14806	28.00%	16583	23.00%	13621	21.00%	12437	3.00%	1777
2002-03	63894	25.40%	16101	27.60%	17635	22.80%	14568	21.20%	13545	3.20%	2045
2003-04	69013	25.60%	17529	27.20%	18771	22.60%	15597	21.40%	14769	3.40%	2346
2004-05	74473	25.80%	19065	26.80%	19959	22.40%	16682	21.60%	16086	3.60%	2681
2005-06	80397	26.00%	20743	26.40%	21225	22.20%	17848	21.80%	17527	3.80%	3055
2006-07	86286	26.20%	22434	26.00%	22434	22.00%	18983	22.00%	18983	4.00%	3451
2007-08	91937	26.40%	24088	25.60%	23536	21.80%	20042	22.20%	20410	4.20%	3861
2008-09	97515	26.60%	25744	25.20%	24574	21.60%	21063	22.40%	21843	4.40%	4291
2009-10	104039	26.80%	27674	24.80%	25802	21.40%	22264	22.60%	23513	4.60%	4786
2010-11	110967	26.80%	29739	24.40%	27076	21.20%	23525	22.80%	25301	4.80%	5326
2011-12	118473	27.00%	31988	24.00%	28433	21.00%	24879	23.00%	27249	5.00%	5924

2.8 Transmission & Distribution Losses

The Transmission & Distribution losses for the state were of the order of 19% during the year 1996-97 as per the information/data furnished by GPCL/GEB. These T&D losses of 19% for 1996-97 has been kept as basis for forecasting the T&D losses during each plan period. It has been assumed that the state would be taking various measures to reduce these losses in the coming years. During the ninth plan period (1997-02), it has been assumed that T&D losses would be reduced by 1% and during 10th and 11th plan periods a constant reduction of 2.5% has been assumed by which the T&D losses are expected to be reduced in each plan. So the T&D losses would be about 13% of total energy available at bus by 31.3.2012. Table 4 gives the year wise anticipated energy requirement at the Bus, peak demand and installed capacity combined for utilities and non-utilities.

Categorywise anticipated energy requirement from 2001-02 to 2011-12 (MkWh)



Ninth Plan end (2001-02)

Tenth Plan end (2006-07)

Eleventh Plan end (2011-12)

The anticipated energy required both at consumer and generation bus end, peak demand as well as installed capacity of the state has been indicated in Table-5.

Table 5. Anticipated Energy required (both at consumer and generation bus end) peak demand and installed capacity of Gujarat state during 1996-97 to 2011-12.

Year	Energy at consumer end (MkWh)	Percentage T&D losses	Captive generating (MkWh)	Energy required at generation bus utilities (MkWh)	Total energy required at generation bus (MkWh)	Peak demand (MW)	Installed capacity (MW)
1996-97	34,120	19.00%	4,108	36,495	40,603	6,528	8,941
1997-98	35,869	18.80%	4,231	38,382	42,613	6,851	9,385
1998-99	37,823	18.65%	4,506	40,371	44,877	7,215	9,884
1999-00	41,953	18.40%	4,799	44,874	49,673	7,986	10,940
2000-01	45,874	18.15%	5,111	49,090	54,20	8,714	11,938
2001-02	50,189	18.00%	5,443	53,781	59,224	9,522	13,044
2002-03	54,378	17.50%	5,606	58,288	63,894	10,273	14,073
2003-04	58,935	17.10%	5,774	63,238	69,012	11,096	15,200
2004-05	63,898	16.55%	5,947	68,526	74,473	11,974	16,403
2005-06	69,308	16.00%	6,126	74,271	80,397	12,926	17,707
2006-07	74,706	15.50%	6,310	79,976	86,286	13,873	19,004
2007-08	79,772	15.25%	6,499	85,438	91,937	14,782	20,249
2008-09	85,278	14.35%	6,694	90,821	97,515	15,679	21,478
2009-10	91,262	14.00%	6,895	97,144	104,039	16,728	22,915
2010-11	97,769	13.50	7,102	103,866	110,968	17,842	24,441
2011-12	104,843	13.00%	7,315	111,158	118,473	19,048	26,094

Note: Although desirable program for T&D loss reduction should aim at achieving targets of 16.50%, 14.00% and 11.50% at the end of IX the, X the and XI the Plan periods, for the purpose of capacity planning, more conservative targets have been assumed.

CHAPTER 3

Review of Power Supply Position in Eighth Plan (1992-97)

3.1 Generation availability

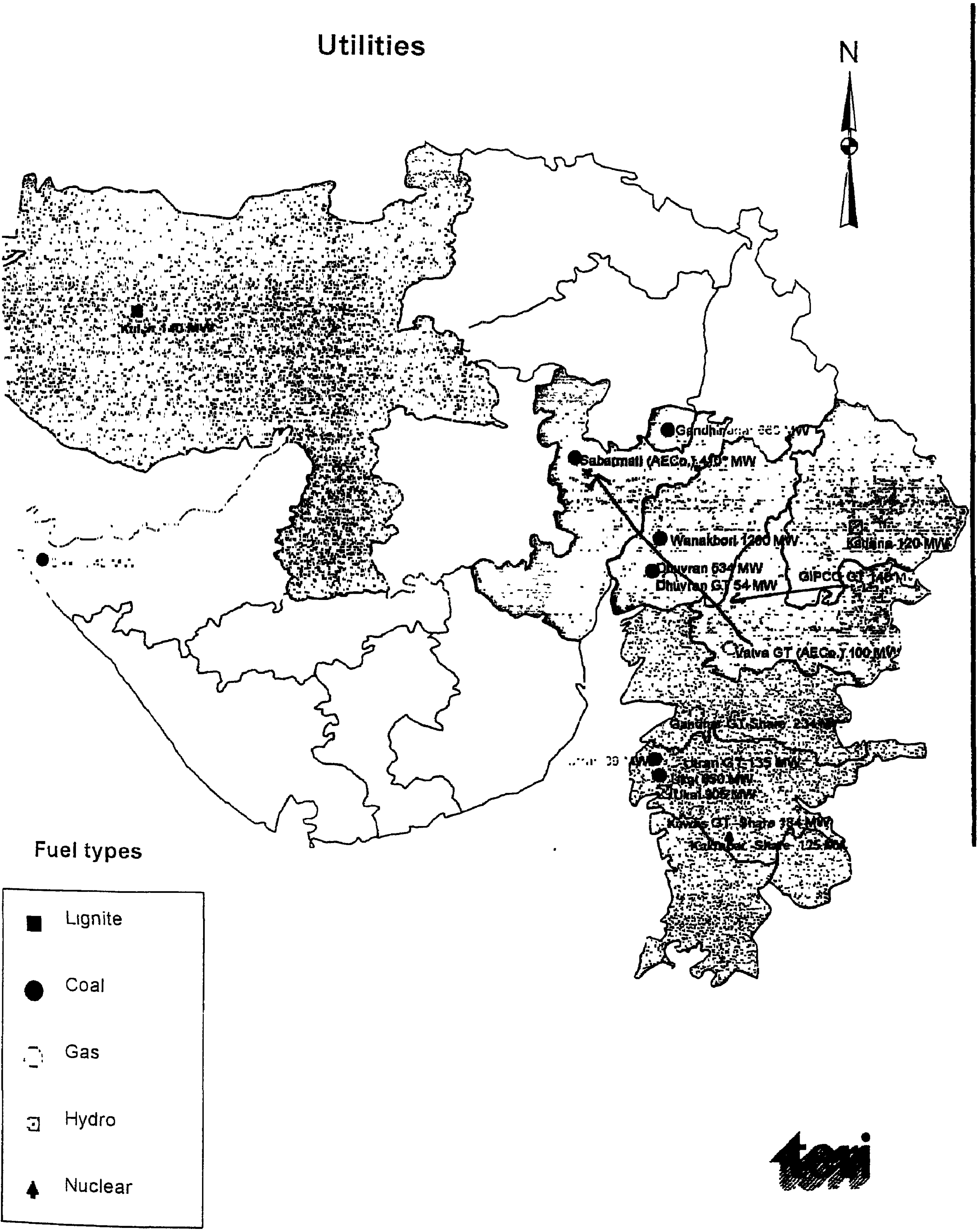
As already discussed in Chapter 2, from power system point of view, Gujarat state has been demarcated into five zones i.e. North (Distt of Palampur, Himmatnagar and Mehsana), Central (Vadodra, Godhra, Kheda and Gandhi Nagar districts), South (Valsad, Surat, Ahwa and Bharuch districts), Saurashtra (Districts of Surendra Nagar, Jamnagar, Junagarh, Amreli, Bhavnagar and part of Rajkot district) and Kutch (Bhuj and part of Rajkot District). Gujarat power supply system mainly comprises installed generating capacities under Gujarat Electricity Board, Ahmedabad Electricity Company (AECO) Ahmedabad, and Gujarat Industrial Power Corp. Ltd (GIPCL). As per the data corresponding to the year 1995-96 furnished by GEB/GPCL, the Gujarat system comprises mainly of Thermal generation and hydro capacity is only about 10% of the total installed capacity in the state excluding the installed capacity of captive power plants. The total installed capacity of the state (utilities only) was 6287 MW on 31.3.96. This includes 1293 MW of allocated share of Gujarat from Central sector stations at Korba, Vindhyachal (stage I), Kawas and Gandhar of NTPC and Tarapur and Kakrapar of NPC. The ownership and type wise details of the installed capacity as on 31.3.96 are given in Table 1A. Details of additional generation capacity expected to be commissioned during 1996-97 are given in Table 1B.

Table 1A. Installed capacity as on 31st March, 1996.

Ownership	Hydro	Coal	Gas	Lignite	Nuclear	Total (1995-96)
GEB	427	3583	189	140		4339
GIPCL/IPP			145			145
AECo.		410*	100			510*
NPC (Guj. share)					285	285
NTPC (Guj. share)		590	418			1008
Total	427	4583	852	140	285	6287

* derated capacity

Utilities



Generating capacity as on March 1996

Table 1B. Additional capacity expected to be commissioned during 1996-97 and anticipated total installed capacity by 31.3.97.

Ownership	Hydro	Coal	Gas	Lignite	Total by 31.3.97
GEB	120	-	-	75	4534
GIPCL/IPP	-	-	675	-	820
AECo.	-	-	-	-	510*
NPC	-	-	-	-	285
NTPC	-	-	-	-	1008
Total	120	-	675	75	7157

* Derated capacity

Table 1C. Actual installed capacity commissioned during 1996-97 and total installed capacity by 31.3.97

Owner	Hydro	Coal	Gas	Lignite	Installed capacity by 31.3.97 (MW)
GEB	-	-	-	-	4414
GIPCL/IPP	-	-	305	-	450
AECo.	-	-	-	-	510*
NPC	-	-	-	-	285
NTPC GEB Share	-	-	-	-	1008
Total	-	-	305	-	6667

It may be mentioned that in addition to the above, a total of 63 captive power plants having aggregate of 1468 MW capacity were also existing in the non-utility sector, out of which only about 1000 MW capacity was in operation. Table 2 below gives the zone-wise details and number of these captive power plants along with aggregate installed capacity.

Table 2. Zone-wise details of power plants in the non-utility sector

Sl. No.	Zone	No of captive power plants as on 31.3.1996			
		Existing		In operation	
		No.	Installed capacity (MW)	No.	Installed capacity (MW)
1	North zone	1	10	1	10
2	Central	18	541	15	374
3	South	32	662	25	453
4	Saurashtra	11	203	9	161
5	Kutch	1	52	-	-
	Total	63	1468	50	998

However for the purpose of the present Master Plan Studies, the power supply position of the state in respect of the utilities sector only has been considered. During the year 1995/96 the state experienced both peaking power and energy shortage of 18.0% and 9% respectively.

From the above table 1-B, it will be seen that during the year 1996-97, 870 MW of generation capacity under state sector is likely to be added. This comprises of hydro -120 MW, Thermal-750 MW (lignite - 75 MW and gas - 675 MW - ESSAR 515 MW + Baroda ext-160 MW). Thus total installed capacity by the end of eighth plan i.e. 31.3.97 is expected to be 7157 MW which includes 1293 MW of allocated share from central sector stations. In this context it is interesting to note that corresponding to the all-India capacity addition program of 30,538 MW in 8th plan, the target capacity addition for Gujarat to be achieved during the 1992-97 was as given below. Table 3, 3-A and 3-B gives the station-wise details of capacity additions during 8th plan period (1992-97).

Table 3. 8th plan (1992-97) Installed Capacity Targets and Likely Achievements

Name of station	**Target (MW)**			**Likely achievements (MW) by 31.3.97**		
	Installed capacity/ Gujarat share	**Gujarat share**		**Installed capacity/Gujarat share**		**Actual achieved**
Central Sector		**Percentage**	**(MW)**	**Central sector share - MW**		
1. Kawas - Gas	538	28.5%	154	Kawas - Gas	154	154
2. Gandhar - Gas	648	36.1%	234	Gandhar - Gas	234	234
3. K A P P (Nuclear)	440	28.5%	125	K A P P (Nuclear)	125	125
4. Sardar Sarovar	1450	16%	232	Sardar Sarovar	-	-
Sub total (Central sector)	3076		745	**Sub total (Central sector)**	513	513
State Sector				**State Sector**		
1. Kutch Lignite-H U-3	70		70	Kutch Lignite	75	75
2. Kadana V-3,4	120		120	Kadana	120	-
3. Panam - H	2 *		2*	Panam	2*	2*
4. Sikka U-2	120		120	Sikka U-2	120	120
5. Utran U-4	78		78	Utran U-4	78	78
Sub total State Sector	388		388	**GEB sub-total***	393	113
Total Gujarat	3464		1133	Essar-IPP	515	305
				Baroda - GIPCL	160	-
				Sub total state sector	1068	578
				Total Gujarat	**1581**	1091

* Not included in aggregate

** Actual installed capacity achieved during 1992-97 was 1091 MW

Table 3-A.

State sector stations (utilities only)	388
Share from central sector stations (Kawas, Kakrapar, Gandhar) & Share from Sardar Sarovar Project	745
Total	1133

As against the above target, on the basis of discussions with Gujarat authorities and CEA, it is assessed that the actual target likely to be achieved during 1992-97 is as below:

Table 3-B

	MW
State sector stations (utilities only)	393
Non-utilities	675
Central sector stations	513
Total	1581@

@ actual achieved 1091 MW

Thus, the actual availability of installed generated capacity to Gujarat system would be about 450 MW more than that was planned for the state corresponding to the all-India target of 30,538 MW during 8th plan.

3.2 Assessment of power position vis-a-vis demand in 8th plan

An assessment of the probable power situation by the end of 8th plan has been made based on GEB's performance for the last ten years with the available installed capacity. It is found that the average peak demand met by Gujarat system (utilities only) has been of the order of 75% of installed capacity on the average. However for the purpose of planning studies a conservative estimate of 73% has been assumed. On this basis the peak demand which can be met with 7157 MW of installed capacity at the end of 8th plan works out to 5225 MW. Based on the assumptions stated under Table 'B' the energy available at bus and the anticipated energy requirement have been worked out and are given in Table 4.

Table 4. Power supply position (utilities) by 31.3.96 and by 31.3.97.

Sl. No.	Item/ Year	1995-96 (Actual)	1996-97 (Anticipated)	Remarks
1	Installed capacity available - MW	6287	7157•	
2	Peak load catered - MW	5245	5225*	* Assuming peak meeting capability of 73%
3	Peak demand - MW	6883 (unrestricted)	6355@	@ Estimates as per the norms adopted.
4	Energy available at bus. (MU)	33571	37719	
5	Energy required (MU)	36895	36495@	
6	Peak load surplus/deficit...%	(-) 18.0	(-)18%	
7	Energy surplus/deficit....%	- 9.0	(+) 3.3%	

• actual installed capacity by 31.3.97 was 6667 MW.

It would be seen from Table 4, above that peaking demand would be deficit by 18% and energy would be surplus by 3.5% by the end of eighth plan against peak and energy shortages of, 18.0% and 9% respectively during the previous year (1995-96).

3.3 Review of Existing Transmission System

System studies for 1995-96 peak conditions were carried out with following objectives:

1. To establish the data bank for future planning studies
2. To validate data by comparing with actual conditions

3. To determine the existing problem areas such as low voltage pockets, highly loaded corridors etc.

3.3.1 *Generation Capacity*

The installed (derated) capacity in the Western Region at the end of March, 1996 was 24030 MW comprising 2874 MW of hydro, 20396 of thermal including gas based generation and 760 MW of Nuclear generation. The details of statewise Generation Capacity are given in the table below:

System	Hydro	Thermal	Nuclear	Total
Gujarat	427	4567		4994
M.P.	845	2958		3803
Maharashtra	1602	8212		9820
Central Sector		4653	760	5413
Total	2874	20396	760	24030

3.3.2 The unitwise installed capacity and derated capacity for Gujarat system and Central Sector are given at Annex- 3.3-1.

3.3.3 *Load Demand (Macro Level Load Estimates)*

Load Generation balance forms the basic input for any load flow study. Recorded data have shown that Regional peak as well as peak for Gujarat system occurred during March, 1996 which were 16740 MW and 5245 MW respectively. Studies were thus carried out for March, 96 conditions. This demand of GEB system was met by GEB's own generation and share from central sector project. Unitwise generation despatches for Gujarat generating stations and central sector stations is given at Annex- 3.3-2.

3.3.4 *Spatial distribution of the load demand*

For the purpose of the studies, it has been assumed that the peak load of all the constituent States would occur at the same time though in actual practice there could be a slight diversity. The load projections have been broken down into sub-stationwise estimates on the basis of distribution pattern of simulation study. Further all the loads connected at lower voltages have been lumped and considered to be incident at corresponding 220 kV or 132 kV bus. Reactive shunt compensation provided at lower voltages have been adjusted against reactive loads. The substationwise load projections are given at Annex-II.

3.3.5 *Transmission network*

In the studies the transmission networks at 400 kV and 220 kV has been fully represented. All 132 kV lines required for evacuation of power from major power stations have also been represented in the studies. The list of transmission lines considered in the studies is given at Annex - 3.3-3.

3.3.6 *Transmission line loadings*

The line loading limits considered in the studies are based on "Manual on Transmission Planning Criterion" revised by CEA in May, 1994. Relevant extracts from the manual are enclosed at Appendix-A.

Permissible line loading limit depend on many factors such as voltage regulation, stability and current carrying capacity (thermal capacity) etc. While Surge Impedance Loading (SIL) gives a general idea of the loading capability of line, it is usual to load the short lines above SIL and long lines lower than SIL (because of the stability limitations). SIL at different voltage levels is given below:

Voltage (kV)	SIL (MW)
132	50
220	132
400	515

Phase angular difference of 30 degree is allowed between the two ends of the line. In case of shunt compensated lines, the SIL will reduced by factor k where

$$k=\sqrt{(1\text{-degree of compensation})}$$

Thus, with a 60% compensation SIL for 400 KV transmission system will be round 325 MW only.

3.3.7 *Transformer taps*

In respect of generator transformers, actual field taps as furnished by the constituents were considered. In respect of grid transformers (ICTs) nominal taps have been considered.

3.3.8 *Generator excitations & voltage limits*

It is assumed that all generators have their excitation set at 1.01 p.u. as per the "Manual on Transmission Planning Criterion".

3.3.9 *Analysis of study results*

As stated in the previous chapters, the study has been carried out for 1995-96 peak conditions with full generation at KSTPS & VSTPS. Maximum care has been taken to achieve the results as per expected realistic conditions based on the present scenario. However, due to theoretical representation of the system i.e. of generation, and loads, voltages at some of the buses were not closer to the realistic values. Further, it is difficult to simulate the grid in which several buses are operating near the nose of the voltage stability (Q-V) curve. In fact load flow failed to converge with the data supplied by GEB. Additional reactive compensation was required to be provided in Indore area to get convergence. This was because of the fact that extremely poor load factor in this region was taken.

The results are plotted at Exhibit I to III

3.3.10 *Western grid*

It has been observed that most of the 400 kV lines in the entire regional grid and some of the 220 kV lines were critically loaded. It has also been observed that due to excessive MVAr flow over lines voltages at receiving end were very poor. Voltages at Indore, Jabalpur, Bhopal, Bina and Western Maharashtra were extremely poor. VSTPS - Jabalpur - Itarsi 400 kV and Korba - Bhilai lines were particularly heavily loaded. The results showing voltages at 400 kV S/S in the region and power flow over 400 kV lines are shown in Exhibit III.

3.3.11 *Gujarat grid*

The results of studies showing voltages at 132 kV and 220 kV buses in GEB grid along with flows on 132 kV and 220 kV lines are shown in Exhibit I & II respectively. From these exhibits it can also be seen that 220 kV lines emanating from Soja (Nardipur) viz., Gandhi Nagar - Soja D/C, Mehsana - Soja 2 x D/C and Soja - Palanpur D/C, were heavily loaded and outage of any of these lines cannot be met with. It has also been observed that power stations were generating high reactive power thereby reducing the margins available for dynamic stability of the system.

Annex 3.3-1

Generation schedule for load flow studies for March, 1996 conditions

Power Station	Installed capacity	Total Derated capacity	Despatch	Remarks
Hydro				
Ukai (H)	305.0	305.0	200.0	
Kadana	120.0	120.0	98.0	
Thermal				
Dhuvaran-1	588.0	588.0	350.0	
Ukai (T) - 1	240.0	240.0	100.0	
Ukai (T) - 2	610.0	610.0	570.0	
A E Company	550.0	550.0	400.0	
Gandhinagar - 1	240.0	240.0	200.0	
Gandhinagar - 2	420.0	420.0	370.0	
Wanakbori-400 kV	630.0	630.0	400.0	
Wanakbori-220 kV	630.0	630.0	400.0	
Sikka	240.0	240.0	205.0	
Kutch Lignite	140.0	140.0	120.0	
Utan Gas	180.0	174.0	130.0	
GIPCL GAS	145.0	145.0	130.0	
Total Gujarat	5038	4992	3673	

Central Sector	Inst. capacity	Share	Total dispatch
Korba	2100	360	1895
Vindhyachal	1260	230	1134
Kawas	645	184	440
Gandhar	648	234	450
KAPP	440	125	-
TAPP	320	160	110
Unallocated	765	306*	
Total	**6178**	**1439**	**3999**

*assumed

Substation	Peak Load	Substation	Peakload
North Gujarat		**South Gujarat**	
Deodhar	64	Haldarwa	59
Zerda	100	Achalia	175
Mehsana	414	Ukai (H)	36
Chatral	184	Utran	37
Palanpur	193	Valthan	340
Dhansura	65	Navsari	265
Vijapur	98	Vapi	209
Himatnagar	57	Kim	95
Sub-total	**1176**	Ichhapur	21
		Waghodia	44
Central Gujarat		**Sub total**	1282
Halol	42		
Viramgam	80	**Saurastra**	
Khapadvanaj	46	Jetpur	120
Vatwa	110	Kodinar	95
Ranasan	240	Savarkundla	100
Karamsad	124	Vartej	100
Gotri	133	Dharangadhra	39
Godhra	56	Keshod	56
Jambua	140	Limbdi	91
Asoj	24	Wanakaner	67
Jawahamagar	30	Jamnagar	61
Fertilizer	31	Bhatia	12
Nandesari	50	Gondal	115
A E Company	430	Paliad	50
Sub-total	**1536**	Sikka	14
		Dhanduka	26
Kutch Region		Ranavav	77
Anjar	92	**Sub total**	**1023**
Panandro	9	**Total**	**5119**
Sub-total	**101**	Transmission losses	**126**
		Total Gujarat	**5245**

List of existing transmission lines in Gujarat grid
(at 132 kV and above)

From Bus	To Bus	Ckt No	Voltage (kV)	Length (kM)	per unit Parameters Res	Reac	Susp
400 kV lines							
Limdi	Jetpur	1	400 00	161.00	.0030	.0332	8884
Limdi	Asoj	2	400 00	166.00	.0031	.0344	.9216
Indor4	Asoj	2	400 00	273.00	.0051	.0566	1.5157
Asoj	Wanakbori	1	400 00	75 00	.0014	.0154	.4108
Wanakbori	Soja	2	400 00	97 00	0018	.0200	5358
Asoj	Ukai	1	400 00	139 00	0026	0286	.7640
Asoj	Jetpur	1	400 00	311 00	0058	0643	1 7211
220 kV lines							
Wanakbori	Kapadwaj	1	220 00	47 00	.0074	0374	.0605
Kapadwanj	Ranasan	1	220 00	55 00	.0087	0440	0712
Gancs2	Hardwara	2	220 00	13 00	.0021	.0104	.0175
Taps2	Vapi	1	220 00	83 00	0132	0665	1076
Vapi	Navsari	1	220 00	81 00	.0129	0648	.1048
Navsari	Valthan	2	220 00	33 00	0052	0266	0430
Mehsana	Deodhar	1	220 00	125 00	0194	1030	1778
Deodhar	Anjar	1	220 00	235 00	0364	.1936	3344
Mehsana	Anjar	1	220 00	280 00	0434	2307	3984
Panandro	Anjar	2	220 00	170 00	0264	.1400	2419
Soja	Palanpur	2	220 00	99 00	.0158	.0790	.1277
Paladpur	Zerda	1	220 00	41.00	0066	.0332	.0538
Soja	Vijapur	1	220 00	25 00	0040	.0200	0323
Jetpur	Keshod	1	220 00	78 00	0124	.0623	.1008
Jetpur	Keshod	2	220 00	78 00	0124	0623	1008
Keshod	Kodinar	1	220 00	65 00	.0101	0536	0924
Kodinar	Svarkandla	1	220 00	104 00	0165	0831	.1344
Valthan	Kim	1	220 00	41 00	0066	0332	0538
Hardwara	Jambua	1	220 00	40 00	0068	0305	.0421
Jambua	Valthan	1	220 00	121 00	0192	0964	1559
Hardwara	Kim	1	220 00	60 00	0093	0495	0854
Utran	Kim	2	220 00	26 00	0041	0208	0336
Ukai (T)	Valthan	2	220 00	64 00	0102	.0516	0833
Wanakbori	Ranasan	1	220 00	81.00	0130	0648	1048
Wanakbori	Asoj	2	220 00	81 00	0130	.0648	1048
Wanakbori	Dhansura	2	220 00	62.00	.0099	0499	0806
Gandhinagar	Soja	2	220 00	16.00	0026	.0132	.0215
Soja	Mehsana	4	220 00	39.00	.0063	.0315	.0510
Asoj	Karamsad	2	220 00	44.00	.0068	.0362	.0626
Jambua	Karamsad	2	220.00	52.00	.0082	.0416	.0672
Karamsad	Hardwara	2	220.00	109.00	.0174	.0873	.1411

List of existing transmission lines in Gujarat grid
(at 132 KV and above)

From bus	To bus	Ckt No	Voltage (kV)	Length (kM)	Per unit	Parameters	
					Res	Reac	Susp
Kakra 2	Hardwara	2	220 00	73 00	.0113	.0602	.1039
Kawas 2	Hardwara	2	220 00	81.00	0126	.0667	.1153
Kawas 2	Ichhapur	1	220 00	8 00	.0012	.0066	.0114
Kawas 2	Vapi	2	220 00	118.00	.0183	.0972	.1679
Kawas 2	Valthan	2	220 00	45.00	0070	.0371	.0640
Kawas 2	Valthan	1	220.00	36.00	.0056	.0297	.0512
Ichhapur	Valthan	1	220 00	28.00	0044	.0231	.0398
Kawas 2	Navsari	2	220 00	46.00	.0071	.0379	.0655
Achalia	Ukai (H)	2	220 00	83.00	.0128	.0684	.1181
Ukai (T)	Achalia	3	220 00	83.00	.0129	.0684	.1181
Achalia	Jambua	4	220 00	47.00	.0072	.0388	.0669
Jambua	Asoj	1	220 00	24 00	.0038	.0198	.0342
Jambua	Waghodra	1	220 00	19.00	.0029	.0157	.0270
Asoj	Waghodra	1	220 00	25.00	.0039	.0206	.0356
Karamsad	Ranasan	2	220 00	70 00	.0108	.0576	.0996
Karamsad	Vartej	2	220 00	208.00	.0322	.1714	.2960
Vartej	Svarkandla	1	220 00	93 00	.0146	.0755	.1338
Svarkandla	Jetpur	1	220 00	96.00	.0152	.0765	.1236
Jetpur	Gondal	2	220 00	27.00	.0044	.0216	.0349
Jetpur	Ranvav	2	220 00	109.00	.0174	.0872	.1411
Gondal	Limdi	1	220 00	110.00	.0171	.0906	.1556
Limdi	Karamsad	1	220 00	118.00	.0183	.0972	.1680
Chatral	Gandhinagar	2	220 00	28.00	.0044	.0230	.0398
Chatral	Virambag	1	220 00	41.00	.0066	.0332	.0538
Virambag	Limdi	1	220 00	70 00	.0112	.0565	.0914
Asoj	Halol	2	220 00	32.00	.0050	.0262	.0455
Halol	Godhra	2	220 00	35 00	.0054	.0288	.0455
Godhra	Kadana	2	220 00	83.00	.0132	.0664	.1075
Kadana	Dhansura	2	220.00	78.00	.0124	.0623	.1008
Himmat Ngr	Vijapur	1	220.00	36.00	.0058	.0291	.0470
Godhra	Wanakbori	1	220.00	36.00	.0058	.0291	.0470
Ukai (H)	Ukai (T)	2	220.00	6.00	.0010	.0050	.0085
Gandhinagar	Ranasan	2	220.00	20.00	.0032	.0164	.0285
Dhansura	Himat Ngr	2	220 00	34.00	.0055	.0274	.0444
Limdi	Dhran	2	220.00	68.00	.0109	.0548	.0888
Nasik 2	Navsari	2	220.00	138.00	.0178	.1323	.2039
Taps 2	Navsari	1	220.00	156.00	.0248	.1247	.2016

List of existing transmission lines in Gujarat grid
(at 132 kV and above)

From bus	To bus	Ckt No	Voltage (kV)	Length (kM)	per unit Parameters		
					Res	Reac	Susp
132 kV Lines							
Jambua	Gotri	1	132 00	5.00	0013	0206	.0361
Jambua	Gotri	2	132 00	5.00	.0013	.0206	.0361
Dhuvran	Dhandi	2	132 00	93.00	.0774	.2300	.0500
Dhuvran	Karamsad	2	132 00	22 00	.0142	.0616	.0140
Vatwa	Dhuvran	2	132 00	50 00	.0418	.1242	.0270
Ranasan	Aecom	2	132 00	12 00	.0102	.0304	.0066
Vatwa	Ranasan	2	132 00	24 00	0202	0598	.0130
Sikka	Jamnagar	2	132 00	29 00	0207	0806	.0175
Sikka	Wankaner	1	132 00	83 00	0689	.2047	0446
Bhatia	Ranavav	1	132 00	14 00	.0033	.0530	0933
Jamnagar	Wankaner	1	132 00	112 00	0929	2760	0600
Wankaner	Anjar	1	132 00	151 00	1254	3726	0810
Wankaner	Limdi	2	132 00	88 00	0728	2162	0470
Sikka	Bhatia	1	132 00	65 00	.0542	1610	0350
Ranavav	Gondal	1	132 00	136 00	1122	3335	.0726
Dhandi	Paliad	2	132 00	57 00	.0472	1402	0305
Gondal	Paliad	2	132 00	139 00	.0053	3427	0466
Jambua	Jawng	2	132 00	35 00	0285	.0852	0185
Dhuvran	Limdi	2	132 00	108 00	0890	2646	0575
Jawng	Fertilizer	2	132 00	7 00	0054	0160	0035
Fertilizer	Asoj	2	132 00	26 00	0216	0644	0140
Fertilizer	Gotri	2	132 00	7 00	0062	0184	0040
Jawang	Nandesari	2	132 00	7 00	.0062	0184	0040
Nandesari	GIPCL	2	132 00	1 00	0004	0050	0012
Nandesari	Asoj	2	132 00	36 00	0294	0874	0190
Gotri	Dhuvran	2	132 00	43 00	.0356	.1058	0230

EXHIBIT - I

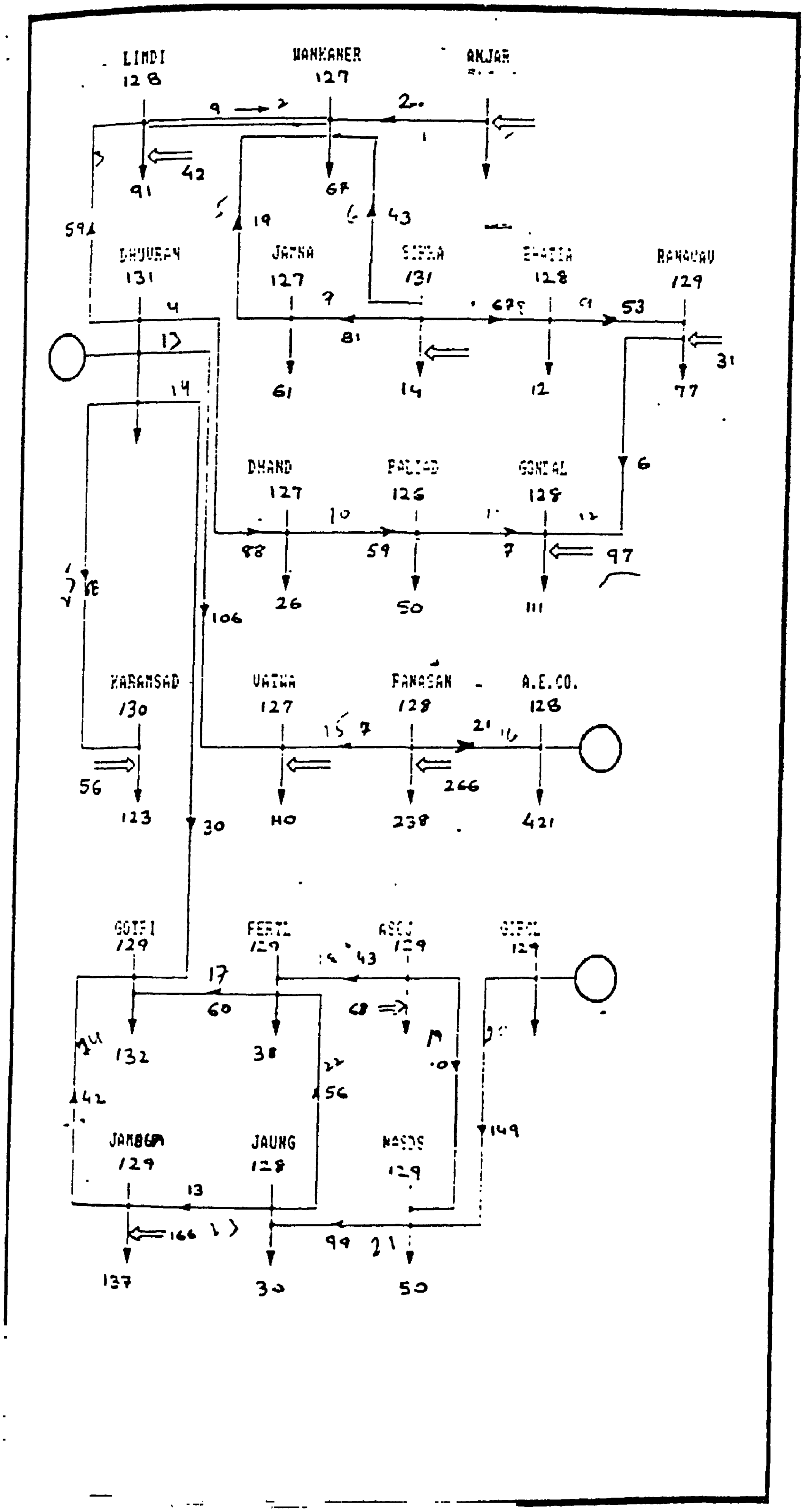
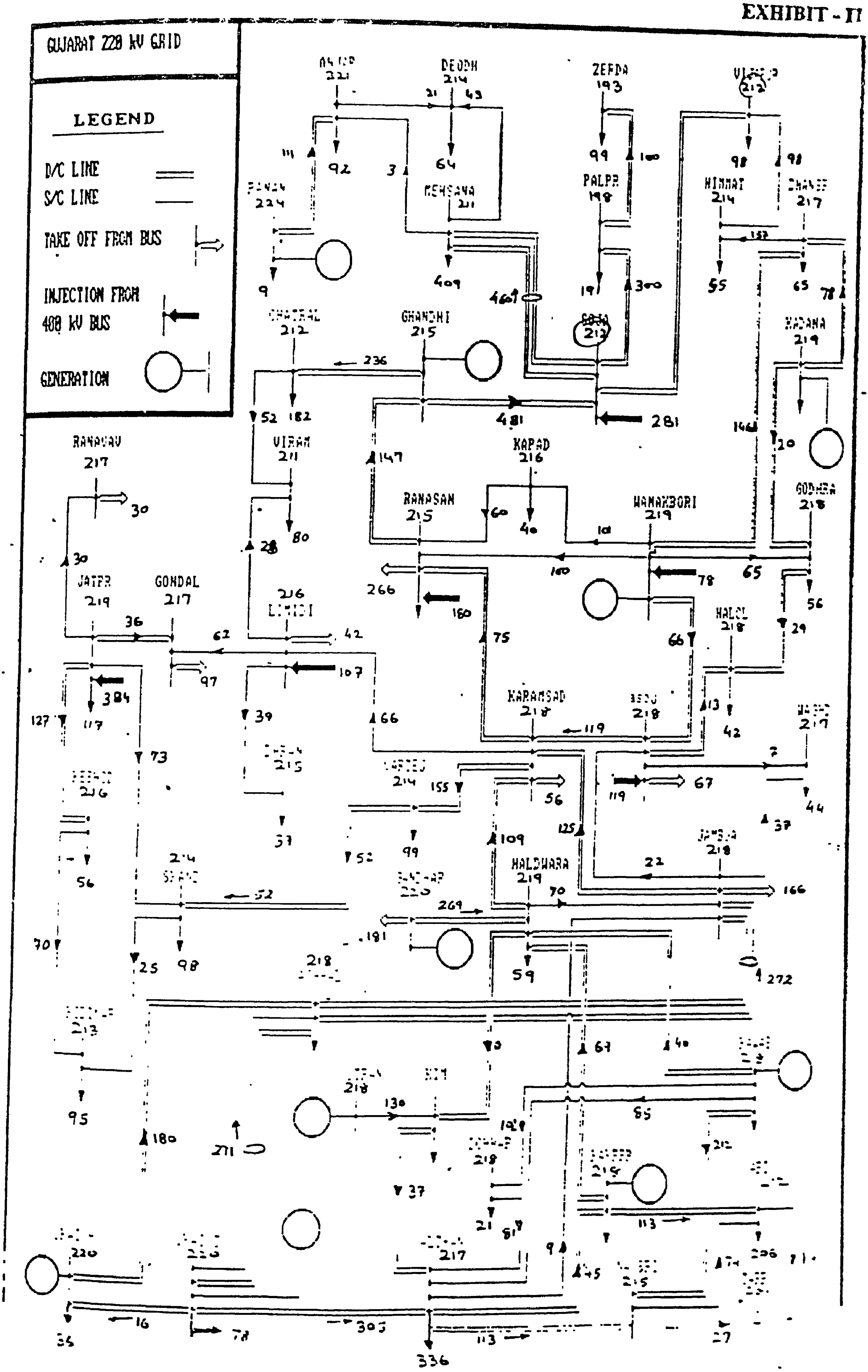

LIMDI
WANKANER
ANJAR
DHUVRAN
JAMNA
SIPKA
BHATIA
RANAVAV
DHAND
BALIAD
GONDAL
KARAMSAD
VATWA
PANASAN
A.E.CO.
GOTRI
FERTL
ASOJ
GIPCL
JAMBUVA
JAUNG
NASDS

EXHIBIT - II


GUJARAT 220 kV GRID
LEGEND
D/C LINE
S/C LINE
TAKE OFF FROM BUS
INJECTION FROM 400 kV BUS
GENERATION
DEODH 214
ZERDA 193
PALPR 198
HIMMAT 214
MEHSANA 211
RANIP 224
CHATRAL 212
GHANDHI 215
SOJA 212
VADANA 219
RANAVAV 217
VIRAM 211
KAPAD 216
RANASAN 215
WANAKBORI 219
GODHRA 218
JATPR 219
GONDAL 217
LIMDI 216
HALOL 218
KARAMSAD 218
HALDWARA 219
JAMBUA 218
236
481
281
266
160
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65
75
66
119
107
384
269
166
272
336
303
113
271
180
130

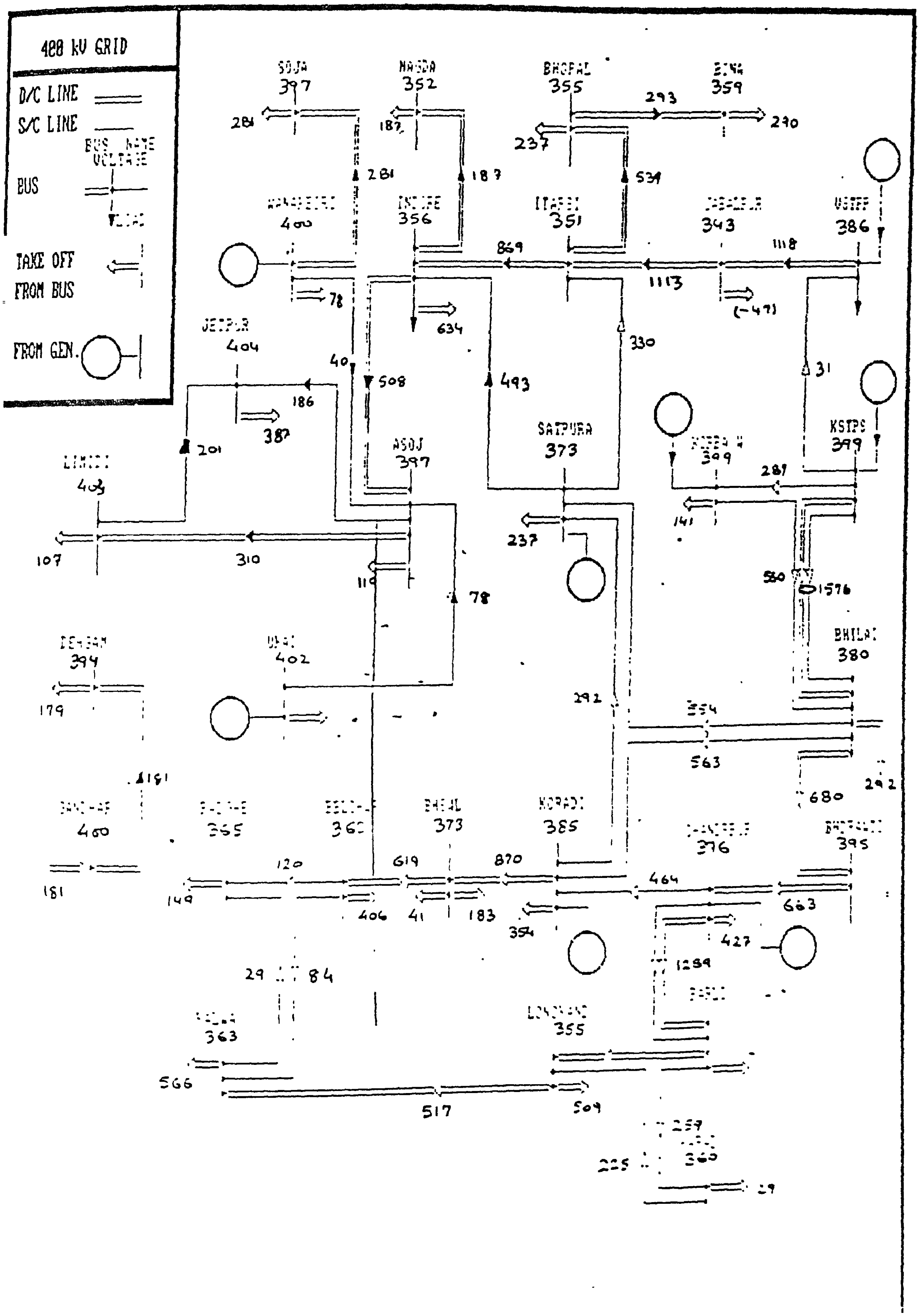
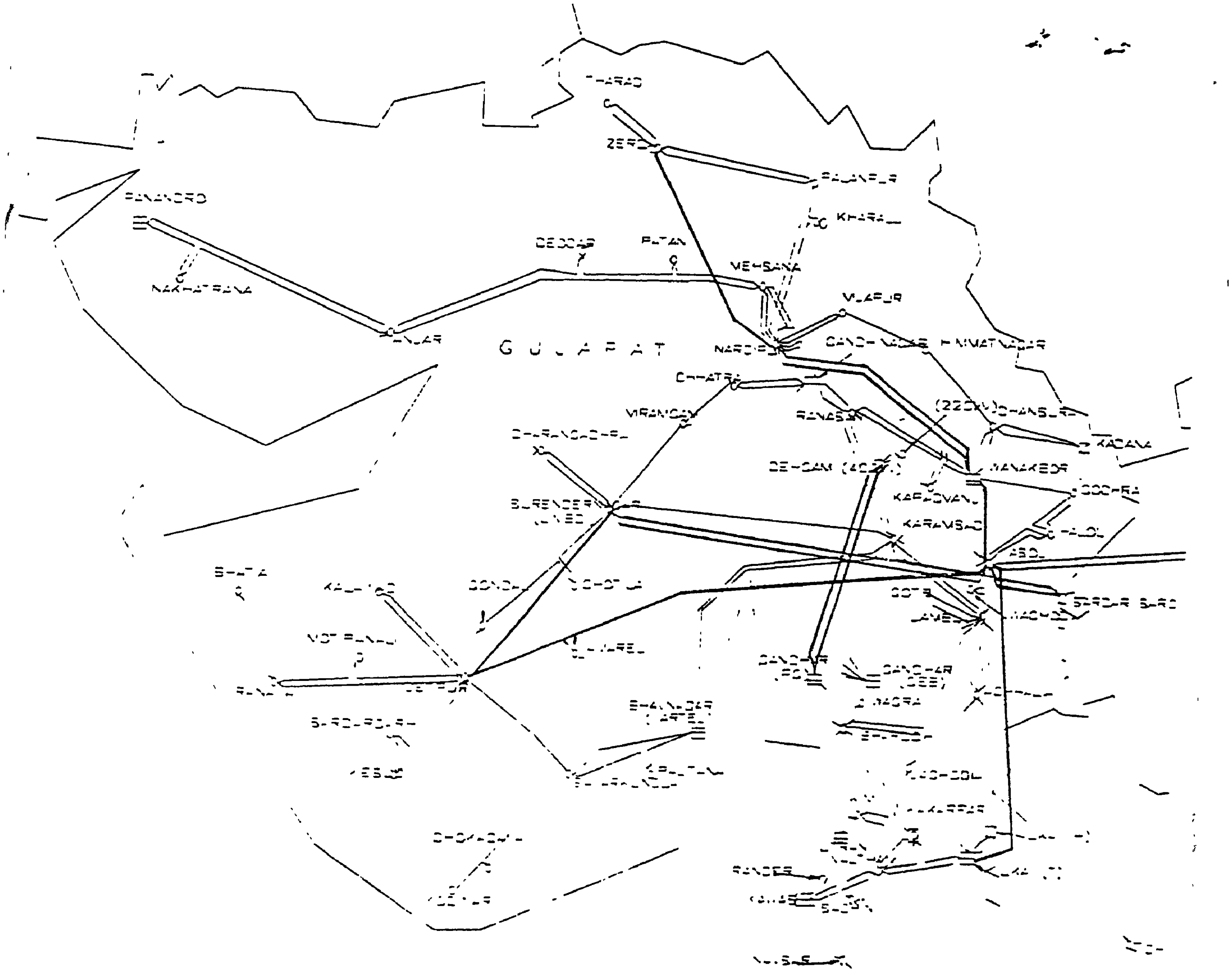

400 kV GRID
D/C LINE
S/C LINE
BUS NAME
VOLTAGE
BUS
TAKE OFF
FROM BUS
FROM GEN.
SOJA
NAGDA
BHOPAL
INDORE
ITARSI
(-47)
JETPUR
ASOJ
SATPURA
KSTPS
1576
BHILAI

EXHIBIT - IV

wer Map of Gujarat Grid showing Transmission Lines (at 220 kV and above) as on 31.3.96



Relevant extracts from CEA's manual on transmission planning criteria

4. Permissible line loading limits

Permissible line loading limit depend on many factors such as voltage regulation, stability, current carrying capacity (thermal capacity) etc. While Surge Impedance Loading (SIL) gives a general idea of the loading capability of the line, it is usual to load short lines above SIL and long lines lower than SIL (because of stability limitations). SIL at different voltage levels is given at ANNEX App - I. Annex App-I also shows line loading (in terms of SIL of uncompensated line) as a function of line length assuming voltage regulation of 5% and phase angular difference of 30° between the two ends of the line. In case of shunt compensated lines, the SIL will get reduced by a factor k, where

$$k = \sqrt{(1\text{-degree of compensation})}$$

For lines whose permissible lone loading as determined from the curve is higher than the thermal loading limit, permissible loading limit shall be restricted to thermal loading limit. The thermal loading limit in respect of standard sizes of ACSR and AAAc conductors employed in EHV transmission lines for different ambient temperatures and different maximum conductor temperatures are given in Annex App-II and same can be followed if permitted by stability and voltage regulation considerations.

5. Steady State Voltage Limits

The steady state voltage shall be maintained within the limits given below:

Voltage (kV rms)		
Nominal	Maximum	Minimum
765	800	728
400	420	380
220	245	198
132	145	122

6. Security Standards

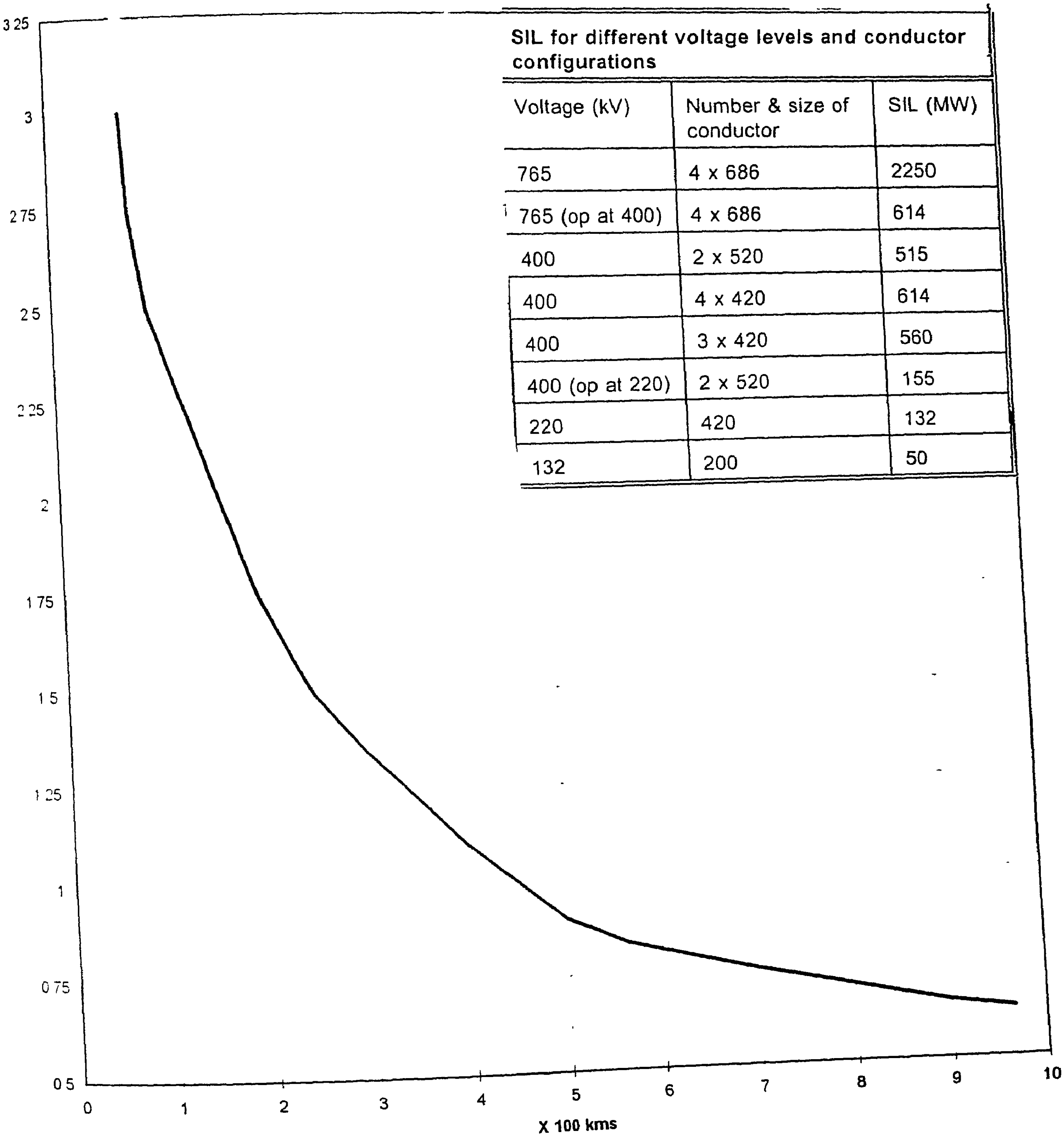
6.1 For the purpose of transmission planning the following security standards shall be followed

6.2 *Steady state operation*

As a general rule, the EHV grid system shall be capable of withstanding without necessitating load shedding or rescheduling of generation, the following contingencies:

- Outage of a 132 kV D/C line or,
- Outage of a 220 kV D/C line or,
- Outage of a 400 kV S/C line or,
- Outage of a 765 kV S/C line or,

Line loading as function of length



SIL for different voltage levels and conductor configurations

Voltage (kV)	Number & size of conductor	SIL (MW)
765	4 x 686	2250
765 (op at 400)	4 x 686	614
400	2 x 520	515
400	4 x 420	614
400	3 x 420	560
400 (op at 220)	2 x 520	155
220	420	132
132	200	50

Annex A-II

Thermal Loading Limits

Conductor type and dimension	Ambient temperature (oC)	Ampacity for Maximum Conductor Temperature (oC)		
		65	75	85
ACSR Panther 210 sq mm	40	312	413	
	45	244	366	
	48	199	334	
	50		311	
ACSR Zebra 420 sq mm	40	454	622	
	45	339	546	
	48	240	493	
	50		454	
ACSR Moose 520 sq mm	40	487	684	
	45	345	595	
	48	214	532	
	50		487	
ACSR Bersimis 680 sq mm	40	565	804	
	45	388	697	
	48	220	621	
	50		565	
AAAC 420 sq mm	40			762
	45			701
	48			661
	50			632
AAAC 520 sq mm	40			843
	45			773
	48			726
	50			694
AAAC 560 sq mm	40			882
	45			808
	48			759
	50			725

uAssumptions : Solar radiations = 1045 W/sq mt., Wind velocity = 2 kM/hour
Absorption coeff. = 0.8, Emissivity coeff = 0.45 Age > 1 year

CHAPTER 4

Issues in developing a Planning strategy for generation expansion in Gujarat vis-a-vis energy resources availability & other considerations

4.1 Present Generation Scenario

Presently about 65% of Gujarat's power needs are met from thermal stations out of which coal-based stations form about 63% of the states thermal installed capacity. Historically therefore the state's electricity production has been very largely dependent on coal. The primary use of oil and gas for power generation has been comparatively lower at about 8% of total installed capacity in the state and confined to a few thermal plants like Dhuvaran, Utran etc. The present pattern of utilization of various types of energy resources are indicated below:

Coal lignite	65%
Gas	8%
Hydro	7%
Central sector (thermal & nuclear share)	20%
Total	100%

4.2 Energy Resources

Gujarat state is not well endowed with conventional resources for power production. There are no coal reserves in the state, but lignite reserves of 324 million tonnes are available at a few locations in Kutch, Saurashtra and South Gujarat areas. As regards hydel power, there are no storage hydro reservoirs in the state. However, Gujarat has oil and natural gas resources in the Southern part amounting to 22130 MCM of gas and 153400 million tonnes of oil. In the national context use of oil for power generation is not being encouraged as indigenous reserves can hardly meet 50% of the countries requirement of oil. Also the gas reserves of 643 BCM are hardly adequate to meet the domestic requirement of the entire country. As against this background it has to be kept in mind that viewed from the national angle the country has immense resources of low grade coal and large resources of hydro power. Gujarat is however located far away from the coal reserves and unfortunately the neighboring states of Maharashtra and Madhya Pradesh in the western region also do not have large hydro resources

potential. So far the coal-based thermal stations in Gujarat have been exclusively dependent on coal supplies from indigenous sources mainly the coal fields located in Madhya Pradesh. In view of this, hitherto the generation planning has been guided mainly by development program of coal mining industry. Because of Gujarat's dependence on indigenous coal supplies, the techno-economic feasibility aspects of using imported coal, gas and oil to take advantage of the long coast line of the state for electricity production purposes has been ignored in the past. Now that the Govt's policy in regard to power development has been vastly liberalized, it is felt that in future planning process the developments in the international oil/gas markets and their impacts on the Indian energy scene should also be taken into consideration, although from considerations of security of supply coal based generation would continue to play an important role in the power development program of the state.

4.3 Salient points associated with use of coal for thermal generation in the state

4.3.1 Coal linkage

India has very large resources of coal having low calorific value and high ash content which is suitable mainly for power generation. Almost 70% of total coal mined in the country is used by the power sector. Indian coals are graded and priced on the basis of useful heat value (UHV) although for the purpose of thermal design calculations gross calorific value (GCV) is used. The calorific value of Indian coals varies from 3800 kcal/kg to 6000 kcal/kg. Higher grade coals designated A, B, C and D grades are used by industries and lower grades of E,F&G are used by the power sector. F&G grade coal is used at pit-head generating stations and E grade is used for load centre stations where coal is required to be transported over distances more than 700 km. The ash content of E grade coal is about 35% and F grade coal is about 40%. These non-coking coals are at present not being beneficiated due to the need for crushing them to a very low size to get rid of the inherent ash by washing. In this process lot of coal is lost due to its fine content and washing in water can get rid of ash to the extent of about 6% only and in the process about 2% moisture is added to the coal. The cost of beneficiation is very high because of large amount of rejects thrown out and it has been found that it is not economical to wash Indian coals unless these have to be transported over distance, above 700 km. However, in view of the need to keep down the ash content to minimize the fly ash nuisance, steps are now being taken to set up beneficiation plants for removing over-burden and other extraneous materials in the coal preparation plants and crush the material to the size of 20-40 mm. In view of these considerations, for Gujarat we would

recommend the use of F grade coal with ash content of 30% blended with imported coal with 12 to 20% ash, so that the resultant sweetened coal has an ash content of about 28% and calorific value of about 4500/4800 kcal/kg. This will reduce the coal consumption resulting in reduction of freight charges. The blended coal will almost be equivalent to D grade coal and the cost of beneficiation will be almost equivalent to the cost difference between F and D grade coals.

4.3.2 *Coal Transport*

Two main sources of indigenous coal for Gujarat are Ib valley coal fields of Orissa and Mand-Raigarh and Korba coal fields in Madhya Pradesh.The coal from the mines can be transported to the generating stations in Gujarat either by rail or by coastal shipping in 30000 to 50000 tonne ships or a combination of both the modes. Freight forms a large component of the fuel cost for Gujarat. In the case of inland transport by rail the distance involved on the average is about 1900 km costing about Rs. 930/tonnes against a pithead coal cost of Rs. 408 for E grade coal. In the case of rail cum sea route, the coal has to travel by rail up to Paradip port from Ib valley a distance of 200 km and then by ship to the Gujarat ports. The transport cost whether by exclusive railway transport or by sea cum rail route happens to be almost the same at Rs. 965 per tonne at current rates. The source of imported coal is likely to be from South Africa, Indonesia, Australia and China at an estimated cost of about $ 46 to $55 per tonne as the CIF cost of this coal. For the present planning studies in both the cases, low sulphur coal has been assumed which does not need desulphurisation equipment.

4.3.3 *Coal Demands for thermal power generation in Gujarat*

A tentative projection of the coal demands per annum for Gujarat's thermal generation program drawn up as per the present planning studies till the end of 11th plan period is indicated in the following table:

Period	Million Tonnes/annum
up to end of 8th plan	14.21
During 9th plan	3.50
10th plan	5.26
11th plan	3.51
Total demand at the end of 11th plan	26.48

4.3.4 Lignite

Lignite is a low grade bituminous coal having a very high percentage of moisture and low in calorific value. Due to this reason, it is usually utilized for generating power at mine mouth thermal stations like Neyveli Station in Tamil Nadu, Pandandro in Gujarat and Birsingsar in Rajasthan. Lignite is mined in open cast mines and the over-burden to coal ratio usually varies from site to site. In the case of Gujarat use of lignite would save on long distance transport involved in use of coal. In the present studies lignite-based thermal stations have been proposed to be set up in the Kutch Zone, Saurashtra & South Zones of the state. The details of the stations proposed are as follows:

Zone	Station	Installed capacity (MW)	Lignite requirement (MT)/Annum
Kutch	Akrimota	2 x 125 MW	979
Southern	Mangrol	2 x 125 MW	979
	Surat	500 MW	1958
Saurashtra	Ghoga (Bhavnagar)	3 x 125 MW	1469

The program for the installation of the generating units would have to match with the production program of lignite at the concerned mines.

4.3.5 Gas for thermal generation

Gujarat is well endowed with hydrocarbon resources and is a large user of petroleum products. The annual consumption of petroleum products by Gujarat is 6 million tonnes which is next only to Maharashtra. The present usage of petroleum products and the reserves of Gujarat and India as a whole are as under:

Reserves of crude oil and natural gas (1995)

	India	Gujarat
Crude oil (million tonnes)	727	155
Natural gas (million cubic meters)	643	90

Gas is at present utilized in power stations of Gujarat which are located in the southern zone of the state. It is estimated that the annual consumption of the gas for the proposed stations in 9th, 10th and 11th plans will be of the order of 2166 MCM, 630 MCM and 2689

MCM respectively.

As against this requirement, government has yet to formulate a clear cut fuel policy, and as such it is not known as to how much gas would be allotted to Gujarat. The present pattern (1995) of offtake of gas to different sectors of the economy is as under:

Power	30%
Fertilizer	40%
Petro chemicals	4%
Industry	12%
Domestic sector (includes captive use)	14%

It is foreseen that allotment of gas for power generation purposes would get a much lower priority compared to fertilizer, domestic sector, petrochemicals and other industries as the indigenous resources are not adequate. Thus gas would have to be imported from oil producing countries in the Middle East, and South East Asia. This would however, entail very heavy expenditure of foreign exchange adding to the already high bill for oil imports. In the present studies therefore the use of gas has been limited to the southern zone and the use of imported LNG in Saurashtra region at the proposed generating stations at Pipavav and Chhara/Sarakhdi.

4.3.6 Oil for thermal generation for Gujarat

Oil is not commonly used for power generation in India except for residual oils from the refineries. In the past therefore, oil was used for power generation only at Dhuvaran power station. This station was also subsequently converted to coal use with only small quantities of residual oil being used in the boilers. Due to very heavy shortage of power in the state, at present GEB has planned a number of small size power plants using heavy oil/LSHS and these stations are to be located near the grid substations mainly to meet the peak demands. These units are planned for commissioning during the 9th plan and early years of the 10th plan. The state has already one refinery and another one is being added. Surplus naphtha and heavy oil will therefore be available from these refineries which could be profitably be used for these stations as practically no transport is involved. Naphtha-based gas turbine stations could be set up in the central and northern zone of the state.

4.3.7 *Barge Mounted Stations*

Gujarat has planned two barge mounted stations to be located along the coast at Dahej and Eastern Saurashtra for supplying power to the coastal areas. It is understood that Karnataka has already accorded approval to about 600 MW of barge mounted power stations to be located on the Mangalore coast. Our preliminary studies however indicate that these stations will prove to be very costly. Power is required at the coastal stations throughout the year and it is not a seasonal load which these are supposed to cater and as such there does not seem to be any advantage to meet these loads by barge mounted stations in preference to fixed land based stations. Such barge mounted stations were used in South America where they travelled along the Amazon river and supplied power to the ship mounted paper mills manufacturing paper from wood available in large quantities along the course of the river. Pakistan is the latest to join the Barge club with 450 MW plant planned around Karachi. However barge mounted stations have a short life span of seven years compared to over 25 years of other projects.

In the proposals however two such plants have been considered and a final decision can be taken about their retention on the basis of the response to the tenders recently floated by Gujarat authorities. If found uneconomical these can be replaced by oil/gas based stations in the area.

4.3.8 *Possibility of power imports from sources located outside Gujarat*

In view of its geographical location, Gujarat would be required to import large chunks of power based on coal as well as hydel resources from the neighboring states/regions, in addition to its share in the central common projects of the western region. Possible sources of hydel power could be mainly from Himachal Pradesh in northern region. Orissa (Eastern Region) could be a major source of coal based thermal power. Prima facie, for a state which is located far away from coal sources, transmission of power is likely to offer a more economical solution than coal transport. Thus the techno-economic feasibility of taking up joint projects located outside the state has to be explored. (Gujarat had earlier attempted this approach in respect of projects like Bandhav, Mand, Raigarh etc.). Due to various reasons joint project arrangements do not often materialize and the negotiations are time consuming. However in the present liberalized regime for power sector development, these types of projects could be taken up by IPPs (Independent Power Producers). Already some IPP projects of this nature are under consideration. For example CEPA power project involving installation of 6 x 660 MW at Ib Valley (Orissa) in 9th Plan for meeting the power needs of Punjab, Haryana, Gujarat, Rajasthan, Madhya Pradesh etc. is under active consideration. Another set

of 10 such units are to be installed in the 10th Plan. Power is to be transmitted to the other states through HVDC involving a distance of 1500 km. Similar arrangements for long term supply could be from Sipat power station in Bilaspur District of Madhya Pradesh (6 x 500 MW assumed for 10th and 11th plan in the studies). Further, there could possibilities of import of large blocks of hydel power from Nepal, where a long term treaty is likely to be concluded shortly between governments of India and Nepal for development of Mahakali valley and other large projects like Pancheswar etc. This requires to be explored as long-term solution.

4.3.9 Nuclear Power

Gujarat has a share of 125 MW in the nuclear power station at Kakrapar and a share of 160 MW from the Tarapur power station of Maharashtra. Gujarat has been allotted a share of 500 MW in the 10th plan from extension of the Tarapur station. There are no plans at present to expand the Kakrapar station. However, if opposition to the setting up of new nuclear plants is eventually overcome in the future, Gujarat would be a strong candidate for additional nuclear capacity, and in the first instance expansion of Kakrapar 2 units of 500 MW each could be considered.

4.4 Non-Conventional Sources of Power

4.4.1 Wind energy

Gujarat has been one of the leading states in the field of installations of wind mills for power generation. The present installed capacity of such wind farms is about 116 MW spread over different locations in the Kutch and Saurashtra coastal areas. It has been estimated that installed capacity of wind mills will go up to 200 MW by the end of 10th plan.

4.4.2 Solar Power

There is a program of installation of two solar stations in Gujarat viz., 150 MW in Kutch and 250 MW in Banaskantha region. In the studies it has been assumed that benefit of this 400 MW from Solar Power could be available by 11th plan.

4.4.3 *Tidal Power*

A project report for installation of 900 MW capacity in a tidal power plant located in coastal Kutch has been prepared. It has been assumed that this power would be available to the Gujarat system in 11th plan.

4.5 Imbalances in power supply in different zones of Gujarat

Gujarat has been divided into 5 power zones. The various zones comprise of 18 districts as given below. The peak demand met and installed capacity as on March 1996 are also indicated in Table 1.

Table 1. Power supply status as on March 1996

Zones	Districts	Peak demand met (MW)	Installed capacity (MW) (utilities)
North	Mehsana, B.Kantha, S. Kantha	1075	-
South	Valsad, Surat, Bharuch, Dang	1442	2132*
Central	Kheda, Vadodra, P.Mahal, Ahmedabad, Gandhinagar	1573	3773*
Saurashtra region	Jamnagar, Bhavnagar, Amreli, Junagarh, Part of Rajkot	1050	240
Kutch region	Kutch and part of Rajkot	105	140
	Total Gujarat	5245	6285

* includes central sector shares

For reducing the extent of regional imbalances in installed capacity in the zone vis-a-vis demand to the extent possible it has been suggested that three power stations should be set up in Saurashtra and the Southern Zone where coal could be imported from indigenous or foreign sources. Gulf of Cambay gas resources could be used for supplying power to the Northern and Central Regions. For the Central region oil based generation as well as generation based on naphtha has been proposed.

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4.6 Planning strategy for generation capacity expansion for Gujarat

4.6.1 As already discussed, till the discovery of on-shore gas in the gulf of cambay, the generation planning for Gujarat has been mainly based on coal although Gujarat has no coal resources of its own. The state has only lignite resources spread over four locations. As far as coal-based stations are concerned it is to be kept in view that coal is transported to the state by rail the cost of transport being almost twice the price of coal, and as such the usual low grade coal with ash content of 40% need not be considered for power generation in the state. Only beneficiated coal with ash percentage of about 28% can be considered or alternatively imported coal with less than 20% ash (ash content 12.20%) can be considered and this coal can be blended with beneficiated indigenous coal. The sources of coal import could be from South Africa, Australia or Indonesia. This coal would have a calorific value of about 6000 kcal/kg and its CIF cost is likely to be of the order of $50 per tonne. Estimated cost of electricity using different types of fuel using various modes of transport are indicated in Appendix IA to ID and corresponding estimates of levelized costs of generation are at Appendix I-E to I-G. The table below indicates the relative unit costs corresponding to the various modes of generation.

Table 2. Relative unit cost corresponding to various modes of generation

	Mode of generation	Cost/unit delivered at grid point in Gujarat (in Rupees)
i.	Pit head generation based on local lignite resources	1.60
ii.	Generation on HBJ gas	1.67
iii.	Pit head generation located outside Gujarat including trans. cost (gen. 1.60 + trans 0.30)	1.90
iv.	Indigenous coal based power station located at load centre in Gujarat	2.11
v.	Imported coal based power station located at load centre in Gujarat	2.25

The above pattern of generation costs along with relevant factors like plans of development of other connected sectors like port facilities, availability of gas, governments future policies regarding import of coal etc. would help in identifying the appropriate strategy to be adopted for power planning in Gujarat.

4.6.2 While planning the future generation pattern for Gujarat, in this exercise the relative costs of generation per unit of electricity corresponding to different fuel resources available/likely to be available have been taken into consideration. It is seen that pit-head generation based on local lignite resources works out to the most economical (of the order of Rs.1.60/kwh). This fact has been reflected in making provision for lignite-based power station to the extent feasible.

4.6.3 After lignite-based generation, the next cheapest source of power would be gas-based generation (about Rs.1.67/kwh). As a strategy Gujarat government should therefore try for maximum allocation of gas for power generation purposes which can achieve an efficiency of almost 58% in the combined cycle mode of operation. However it must be kept in mind that other sectors like house-hold sector, fertilizer and petro/chemical sectors as well as some other industries would be strong contenders for gas allocation.

4.6.4 The other fuel resource available for power generation is coal which is abundantly available in the country although not locally in Gujarat. Because of long distances involved in coal transport, costs involved in delivering coal to the power stations located in Gujarat is very high-as much 200% of the cost of coal. However Gujarat has a very long coast line and almost two thirds of the state is approachable from the coast and the economics of sea-sum-rail route also would form an important consideration in locating the coal-based thermal stations. Availability of port facilities also opens up the possibility of using imported coal for power generation suitably blended with indigenous coal selectively. Another option available to Gujarat would be to set up power stations at pit-head locations outside the state in collaboration with central organizations like NTPC or state undertakings like SEBs or IPPs. This option would involve transmissions of bulk power over long distances and apart from doing away with hassle of railway transport offers an attractive alternative at competitive cost/kwh delivered. Under this option it would be worthwhile considering projects like setting up a pit-head station at Ib valley/Mahanadi area in Orissa or a pit-head station in the Korba area of Madhya Pradesh and transmit Gujrat's share in these power stations over HVDC or 400 kV AC transmission lines at suitable grid points in the state power system.

4.6.5 An analysis of the relative economics of the cost of generation with gas-based generation (combined cycle operation mode) estimated to be of the order of Rs.1.67/kwh compared to coal-based generation where the cost of generation varies in the range of Rs.1.90 to Rs.2.25 per kwh, leads us to another interesting conclusion. In the daily operation cycle of

the thermal stations in Gujarat system, it would be preferable to assign the highest merit order to the gas-based combined cycle plant. Any Backing down of generation if necessary may be done on the old thermal units (e.g.Dhuvaran TPS units). In other words the combined cycle gas stations should be operated at the highest possible PLF to realize maximum possible advantage of this mode of generation. If it becomes necessary, two-shift operation may have to resorted to in respect of old thermal units. This is all the more relevant in view of the fact that corresponding to the generation capacity expansion plan envisaged in the present exercise, energy surpluses varying from 14% to 20% are foreseen during the 9th, 10th and 11th plan periods.

Annexure 4.1

Calculation of fuel requirement

Projects	Type	Ownership	Capacity	Generation Mkwh	Fuel consumption per kwh	Fuel	
						Coal (thousand tonnes)	Gas (million cubic meter)
Total present installed capacity (utilities)			6287				
Kutch, Unit-3	Lignite	GEB	75	411	0.96	395	
Kadana project, Stage-II	Hydro	GEB	120				
Baroda Extn.	Gas	GIPCL	160	800	0.21		168
Essar Gujarat Power Plant, Unit 1-3	Gas	IPP	315	1575	0.21		331
Essar Gujarat Power Plant, Unit 1-4	Steam	IPP	200	1000			
Sub-total			870				
9th plan (1997-2002)							
AECo., A'bad	Heavy oil	IPP	150	750	0.18	135	
AECo., A'bad	Coal	IPP	120	658	0.64	421	
Bhavnagar Unit 1-3	Lignite	GPCL	375	2057	0.96	1975	630
Chhara/Sarakhdi	Gas	GPCL	600	3000	0.21		680
Gandhar, Unit 1-4	Gas	GTEC	648	3240	0.21		
Gandhinagar Extn, Unit-5	Coal	GEB	210	1152	0.64	737	
Hazira	Gas	GPCL	160	800	0.21		168
Jamnagar by reliance	Coal	IPP	500	2500	0.64	1600	
Mangrol Unit 1-2	Lignite	GIPCL	250	1371	0.96	1316	
Pipavav	Gas	GPCL	655	3275	0.21		688
Small power stations near s/s	Heavy oil	GEB	600	3000	0.18	540	
Sardar Sarovar	Hydro	Joint sector	232				
Vindhyachal stage II	Coal	NTPC	180				
Wanakbori Extn Unit-7	Coal	GEB	210	1152	0.64	737	
Barge mounted	Heavy oil	GEB	130	650	0.18	117	
Unallocated share	Coal	Central sector	245				
Retirement Dhuvran TPS							
Total additions during the 9th plan			5265				

Projects	Type	Ownership	Capacity	Generation Mkwh	Fuel consumption per kwh	Fuel	
						Coal (thousand tonnes)	Gas (million cubic meter)
10th plan (2002-2007)							
Akrimota Unit 1-2	Lignite	GMDC	250	1371	0.96	1316	
Bhavnagar Unit-4 Extn	Lignite	GPCL	250	1371	0.96	1316	
Chhara/Sarakhdi	Gas	GPCL	600	3000	0.21		630
Muddra	Coal	GPCL	500	2742	0.64	1755	
Pipavav	Coal (imported)	GPCL	1000	5484	0.64	3510	
Replacement Dhuvran	Coal	GEB	534				
Surat Unit-4	Lignite	GEB	500	2742	0.96	2632	
Share from CEPA unit 1-2	Coal	CEPA	1320				
Tarapur Extn.	Nuclear	NPC	500				
Wind project	Wind	GEB	200				
Small power stations near s/s	Heavy oil	GEB	600	3000	0.18	540	
Sipat TPS	Coal	MP	500				
Retirement Ukai (2x120), G Nagar (2x120)							
Total additions during the 10th plan			**6754**				
11th plan (2007-2012)							
Bhavnagar Unit-5	Lignite	GPCL	250	1371	0.96	1316	
Gandhar Extn	Gas	GTEC	655	3275	0.21		688
Gujarat West Coast TPS	Coal	GEB	500	2742	0.64	1755	
Kutch Tidal	Tidal	GEB	900				
Muddra	Coal	GPCL	500	2742	0.64	1755	
Sipat TPS	Coal	MP	1000				
Mangrol Extn.	Lignite	GIPCL	500	2742	0.96	2632	
Pipavav Extn.	Gas	GPCL	655	3275	0.21		688
Parbati valley	Hydro	GEB	500				
Share from CEPA	Coal	CEPA	660				
Solar plant in Kutch	Solar	GPCL	400				
Kawas Extn Stage II	Gas	GEB	650	3250	0.21		683
Chhara/Sarakhdi	Gas	GPCL	600	3000	0.21		630
Replacement Ukai+G.nagar	Coal	GEB	480				
Retirement Wanakbori 210 + ukai 400							
Total additions during the 11th plan			**8250**				

Appendix: I A

Estimated cost per unit delivered at GEB grid bus for a pit-head generating station using indigenous coal

No.	Item	Inputs	Calculations	Remarks
1.	Capital cost of plant Rs/Kw	32,500		
2	Int	10.70%	2434.25	
3.	Dep.	7.84%	2548.00	
4.	Annual fixed O&M cost	2.50%	812.50	
5	Total annual costs/Kw		5794.75	
6.	Annual generation Kwh/Kw	6000		
7.	Aux. consumption (9%) & Transmission loss (2%)	11%		
8	Units available for sale		5340.00	
9.	Station heat rate Kcal/Kwh	2500		
10	Cal value of fuel Kcal/Kg	4200		F grade coal
11.	Fuel consumption Kg/Kwh		0 60	
12.	Base pithead price of coal Rs/MT	264		
13.	Royalty/custom duty etc. Rs/MT	54		
14	Pithead/CIF price per MT		318.00	
15.	Transport	100		
16.	Port handling charges			
17.	Total coal cost/MT		418.00	
18.	Fuel oil cost for 3.5 ml/kWh @ Rs. 6 / Kl	0.000006	0 000021	
19.	Total fuel cost per Kwh		0.25	
20.	Total fixed cost/Kwh		1.09	
21.	Return on Equity %	16%	0.29	Debt equity ratio 70:30
22.	**Total unit cost (Rs/kWh) at generation bus**		**1.63**	
23	Transmission cost Rs/kWh		0 30	As per CEPA project
24	**Total unit cost (Rs/kWh) at grid bus**		**1.93**	**TOTAL COST**

Appendix: I B

Estimated cost per unit delivered at generating station located in Gujarat using indigeneous coal transported by rail/rail cum sea

No.	Item	Indigenous coal				Remarks
		Inputs	Calculations	Inputs	Calculations	
		Transport by rail		Transport by rail & sea		
		1 MT/1900 km		200 km @ 0.55/tkm + $ 18.00/MT coastal shipping		
1.	Capital cost of plant Rs/Kw	32.500		32,500		
2	Int.	10.70%	2434.25	10.70%	2434.25	
3	Dep	7.84%	2548.00	7.84%	2548.00	
4.	Annual fixed O&M cost	2.50%	812.50	2.50%	812.50	
5	Total annual costs/Kw		5794.75		5794.75	
6	Annual generation Kwh/Kw	6000		6000		
7	Aux. consumption	9%		9%		
8	Units available for sale		5460.00		5460.00	
9	Station heat rate Kcal/Kwh	2500		2500		
10	Cal value of fuel Kcal/Kg	4500		4500		Beneficiated E grade coal
11.	Fuel consumption Kg/Kwh		0.56		0.56	
12	Base pithead price of coal Rs/MT	322		322		
13	Royalty/custom duty etc Rs/MT	86		86		
14	Pithead/CIF price per MT		408.00		408.00	
15	Transport	930		740		
16	Port handling charges			225		
17	Total coal cost/MT		1338.00		1373.00	
18	Fuel oil cost for 3.5 ml/kWh @ Rs. 6 / Kl	0.000006	0.000021	0.000006	0.000021	
19	Total fuel cost per Kwh		0.74		0.76	
20	Total fixed cost/Kwh		1.06		1.06	
21	Return on Equity %	16%	0.29	16%	0.29	Debt equity ratio 70:30
22	Total unit cost		2.09		2.11	

Total Unit Cost for indigenous coal (Rs/kWh) = 2.11

Appendix: I B

Estimated cost per unit delivered at generating station located in Gujarat using indigeneous coal transported by rail/rail cum sea

No.	Item	Indigenous coal				Remarks
		Inputs	Calculations	Inputs	Calculations	
		Transport by rail		Transport by rail & sea		
		1 MT/1900 km		200 km @ 0.55/tkm + $ 18.00/MT coastal shipping		
1.	Capital cost of plant Rs/Kw	32.500		32,500		
2.	Int.	10.70%	2434.25	10.70%	2434.25	
3	Dep	7.84%	2548 00	7.84%	2548.00	
4.	Annual fixed O&M cost	2.50%	812.50	2.50%	812.50	
5	Total annual costs/Kw		5794.75		5794.75	
6.	Annual generation Kwh/Kw	6000		6000		
7	Aux. consumption	9%		9%		
8	Units available for sale		5460 00		5460 00	
9	Station heat rate Kcal/Kwh	2500		2500		
10	Cal value of fuel Kcal/Kg	4500		4500		Beneficiated E grade coal
11	Fuel consumption Kg/Kwh		0 56		0.56	
12	Base pithead price of coal Rs/MT	322		322		
13	Royalty/custom duty etc Rs/MT	86		86		
14	Pithead/CIF price per MT		408 00		408 00	
15	Transport	930		740		
16	Port handling charges			225		
17	Total coal cost/MT		1338 00		1373 00	
18	Fuel oil cost for 3.5 ml/kWh @ Rs. 6 / Kl	0 000006	0 000021	0 000006	0 000021	
19	Total fuel cost per Kwh		0 74		0 76	
20	Total fixed cost/Kwh		1 06		1 06	
21	Return on Equity %	16%	0 29	16%	0 29	Debt equity ratio 70:30
22	Total unit cost		2.09		2.11	

Total Unit Cost for indigenous coal (Rs/kWh) = 2.11

Appendix: I C

Estimated cost per unit at generating station bus located in Gujarat using imported coal

No.	Item	Imported coal			Remarks
		Inputs	Calculations	Upper limit	
		Transport by sea			
1.	Capital cost of plant Rs/Kw	32,500			
2	Int	10.70%	2434.25		
3.	Dep	7.84%	2548.00		
4	Annual fixed O&M cost	2.50%	812.50		
5.	Total annual costs/Kw		5794.75		
6	Annual generation Kwh/Kw	6000			
7.	Aux. consumption	9%			
8.	Units available for sale		5460.00		
9.	Station heat rate Kcal/Kwh	2500			
10.	Cal. value of fuel Kcal/Kg	6000			
11.	Fuel consumption Kg/Kwh		0.42		
12.	Base pithead (CIF) price of coal Rs/MT	$ 46 00		$ 53.00	The prices taken here are the minimum and maximum expected prices
13	Conversion rate for US $	Rs 35.00			
14	Royalty/custom duty etc. Rs/MT	20%			
15	Pithead/CIF price per MT		1932.00		
16.	Transport	Incld. in coal price			
17.	Port handling charges	225			
18	Total coal cost/MT		2157 00		
19	*Fuel oil cost for 3.5 ml/kWh @ Rs 6 / Kl*	0.000006	0 000021		
20	Total fuel cost per Kwh		0.90		
21.	Total fixed cost/Kwh		1.06		
22	Return on Equity %	16%	0 29		Debt. equity ratio 70 30
23	**Total unit cost Rs/kWh**		2.25	2.37	The unit cost of power will vary between Rs 2.25 and 2.37 depending upon the CIF price of imported coal

Appendix: I D

Estimated cost per unit at generating station bus located in Gujarat using gas as a fuel

No.	Item	Gas		Remarks
		Inputs	**Calculations**	
		Transport by HBJ		
1	Capital cost of plant Rs/Kw	27,000		
2.	Int	10.70%	2022.30	
3.	Dep.	8.24%	2224.80	
4.	Annual fixed O&M cost	2.50%	675.00	
5.	Total annual costs/Kw		4922.10	
6.	Annual generation Kwh/Kw	6000		
7.	Aux. consumption	3%		
8	Units available for sale		5820 00	
9	Station heat rate Kcal/Kwh	1800		
10	Cal. value of fuel Kcal/Kg	8600		
11.	Fuel consumption CuM/Kwh		0.21	
12	Base price (Rs/1000 CuM)	1,850		
13	Royalty/custom duty etc. Rs/1000 CuM	185		
14	Pithead/CIF price per 1000 CuM		2035 00	
15	Transport (per 1000 CuM)	850		
16	Total gas cost/1000 CuM		2885 00	
17	Total fuel cost per Kwh		0 60	
18	Total fixed cost/Kwh		0 85	
19	Return on Equity %	16%	0 22	Debt equity ratio 70 30
20	Total unit cost Rs/kWh		1.67	

Appendix : 1E

LEVELIZED COST OF PITHEAD GENERATION WITH INDEGENOUS COAL

Assumptions and technical parameters	
Heat rate, KCal/KWh	2500
Efficiency of power generation	0.344
Generated power output, KW	500000
Equivalent Utilisation period, hours/year	6000
Gross units generated, KWh/year	3000000000
Net units generated, KWh/year	2730000000
Capital costs of the power plant(taxes,insurance, included) Rs/KW	32500
Capital cost, Rs	16250000000
Discount Factor	0.14
Annuity factor per year(CRFe)	0.145498408
Annualised captital cost, Rs/year	2364349129
Constant operating costs(2.5% of capital cost), Rs/year	406250000
Cost of coal, Rs/Kg	0.418
Heat supplied in fuel lignite/coal, K.Cal/Kg	4200
Fuel oil used, ml/kwh	3.5
cost of fuel oil, Rs/kl	6
cost fuel oil consumed, Rs/kwh	0.021
Cost of Heat supplied in fuel lignite/coal, Rs/year	809428571.4
Annualised Total cost, Rs/year	3580027700
Economic levelized cost Rs/KWh	1.31
Financial cost of generation	
Fraction of equity in project finance(1:4),Rs(fe)	3250000000
Fraction of debt in project finance, Rs(fd)	13000000000
Fraction of equity in project finance,(fe)	0.3
Fraction of debt in project finance, (fd)	0.7
Cost of debt, per annum(rd)	0.107
Marginal tax rate(TR)	0.43
System operating life, years(OL)	25
System tax life, years(TL)	12
After tax cost of capital (r)	0.090693
CRF(r,TL)	0.140138567
CRF(r,OL)	0.102378449
CRF(financial)	0.133684827
Annualized cost(financial)	3388057007
Financial Levelized cost of power, Rs/KWh	1.24

Appendix : 1F

LEVELIZED COST OF LOAD CENTRE GENERATION LOCATED IN GUJARAT USING INDEGENOUS COAL

Assumptions and technical parameters	
Heat rate, KCal/KWh	2500
Efficiency of power generation	0.344
Generated power output, KW	500000
Equivalent Utilisation period, hours/year	6000
Gross units generated, KWh/year	3000000000
Net units generated, KWh/year	2730000000
Capital costs of the power plant(taxes,insurance, included) Rs/KW	32500
Capital cost, Rs	16250000000
Discount Factor	14%
Annuity factor per year(CRFe)	0.145
Annualised captital cost, Rs/year	2364349129
Constant operating costs(2.5% of capital cost), Rs/year	406250000
Cost of coal, Rs/Kg	1.33
Heat supplied in fuel lignite/coal, K.Cal/Kg	4500
Cost of Heat supplied in fuel lignite/coal, Rs/year	2210000000.00
Annualised Total cost, Rs/year	4980599129
Economic levelized cost Rs/KWh	1.82
Financial cost of generation	
Fraction of equity in project finance(1:4),Rs(fe)	3250000000
Fraction of debt in project finance, Rs(fd)	13000000000
Fraction of equity in project finance,(fe)	30%
Fraction of debt in project finance, (fd)	70%
Cost of debt, per annum(rd)	10.7%
Marginal tax rate(TR)	43%
System operating life, years(OL)	25
System tax life, years(TL)	12
After tax cost of capital (r)	0.090653
CRF(r,TL)	0.140
CRF(r,OL)	0.102
CRF(financial)	0.134
Annualized cost(financial)	4788628435
Financial Levelized cost of power, Rs/KWh	1.75

Appendix : 1G

LEVELIZED COST OF LOAD CENTRE GENERATION LOCATED IN GUJARAT USING IMPORTED COAL

Assumptions and technical parameters	
Heat rate, KCal/KWh	2500
Efficiency of power generation	0.344
Generated power output, KW	500000
Equivalent Utilisation period, hours/year	6000
Gross units generated, KWh/year	3000000000
Net units generated, KWh/year	2730000000
Capital costs of the power plant(taxes,insurance, included) Rs/KW	32500
Capital cost, Rs	16250000000
Discount Factor	14%
Annuity factor per year(CRFe)	0.145
Annualised captital cost, Rs/year	2364349129
Constant operating costs(2.5% of capital cost), Rs/year	406250000
Cost of coal, Rs/Kg	2.16
Heat supplied in fuel lignite/coal, K.Cal/Kg	6000
Cost of Heat supplied in fuel lignite/coal, Rs/year	2696250000.00
Annualised Total cost, Rs/year	5466849129
Economic levelized cost Rs/KWh	2.00
Financial cost of generation	
Fraction of equity in project finance(1:4),Rs(fe)	3250000000
Fraction of debt in project finance, Rs(fd)	13000000000
Fraction of equity in project finance,(fe)	30%
Fraction of debt in project finance, (fd)	70%
Cost of debt, per annum(rd)	10.7%
Marginal tax rate(TR)	43%
System operating life, years(OL)	25
System tax life, years(TL)	12
After tax cost of capital (r)	0.090693
CRF(r,TL)	0.140
CRF(r,OL)	0.102
CRF(financial)	0.134
Annualized cost(financial)	5274878435
Financial Levelized cost of power, Rs/KWh	1.93

Appendix : 1H

LEVELIZED COST OF GENERATION IN GTCC LOCATED IN GUJARAT USING NATURAL CAS

Assumptions and technical parameters	
Heat rate, KCal/KWh	1800
Efficiency of power generation	0.48
Generated power output, KW	500000
Equivalent Utilisation period, hours/year	6000
Gross units generated, KWh/year.	3000000000
Net units generated, KWh/year	2910000000
Capital costs of the power plant(taxes,insurance, included) Rs/KW	27000
Capital cost, Rs	13500000000
Discount Factor	14%
Annuity factor per year(CRFe)	0.151
Annualised captital cost, Rs/year	2038311021
Constant operating costs(2.5% of capital cost), Rs/year	337500000
Cost of Natural Gas, Rs/1000 Nm^3	2885.00
Heat supplied in fuel Natural Gas, K.Cal/Nm^3	8600
Cost of Heat supplied in fuel Natural Gas, Rs/year	1811511627.91
Annualised Total cost, Rs/year	4187322649
Economic levelized cost Rs/KWh	1.44
Financial cost of generation	
Fraction of equity in project finance(1:3),Rs(fe)	3375000000
Fraction of debt in project finance, Rs(fd)	10125000000
Fraction of equity	30%
Fraction of debt	70%
Cost of debt, per annum(rd)	10.7%
Marginal tax rate(TR)	43%
System operating life, years(OL)	20
System tax life, years(TL)	12
Depreciation rate per annum, %	8.24
After tax cost of capital (r)	0.074793
CRF(r,TL)	0.129
CRF(r,OL)	0.098
CRF(financial)	0.124
Annualized cost(financial)	3824948648
Financial Levelized cost of power, Rs/KWh	1.31

CHAPTER 5

Generation capacity expansion program for Gujarat during ninth, tenth & eleventh plan periods

5.1 Generation capacity expansion program during Ninth Plan (1997-02)

5.1.1 Assuming a capacity addition of 870 MW during the year 1996-97, during the period 1997-02, 5027 MW of generation installed capacity is proposed to be added in the utility sector to meet the anticipated peak demand of 8647 MW (utilities only). This capacity addition is exclusive of generation capacity to be added by way of captive power plants. This proposed generation capacity addition of 5020 MW comprises:

	MW
Ongoing projects	412
Technically approved projects	1730
New identified projects	2885

Total:	**5027**

For selecting the various power plants for yielding benefits during the ninth plan period, considerations of factors like present status of the project, gestation periods involved for commissioning the plant, fuel linkage and environmental clearances etc were the main consideration. For bridging the gap between power supply and power demand on urgent basis, short gestation small capacity, power plants based on heavy oil with an aggregate capacity of 600 MW have been proposed for installation at various load centres on a selective basis. These small power stations are proposed to be located at major grid substation locations where the load demand justifies location of the plant. Similarly two Barge Mounted Power Stations one with installed capacity of 100 MW and the second with 30 MW have also been proposed. A brief discussion on the projects considered for the 9th plan capacity expansion program follows. The details of the station-wise capacity additions are indicated in the enclosed Table A.

5.1.2 Ongoing projects

i. *Sardar Sarovar hydro Electric Project*

Sardar Sarovar hydro electric power project with an installed capacity of 1450 MW is presently under construction. The project is a joint sector project the partners being Gujarat, Madhya Pradesh and Maharashtra. Gujarat's share of 232 MW in this project is likely to be available by end of 9th plan period.

ii. *Vindyachal Power Station (NTPC)*

The Vindyachal Power Station of NTPC is located in Madhya Pradesh with an existing installed capacity of 1260 MW (6 x 210 MW). This station is being expanded to add 1000 MW (2 units of 500 MW each) at this station during the period (1997-2002). Presently Gujarat has a share of 18% i.e 230 MW in the existing installed capacity. Assuming that the existing 18% share for Gujarat continues in the extension project also, the share of Gujarat from this station would increase by 180 MW aggregating to a total of 410 MW.

5.1.3 Techno-economically approved projects

i. *Gandhinagar Thermal Power Station*

The existing power station at Gandhinagar near the state capital Ahmedabad comprises of 2 coal based thermal generating units of 120 MW each and two units of 210 MW each. It is proposed to expand the station by installing another unit of 210 MW during ninth plan, thus augmenting the total installed capacity of Gandhinagar Power Station to 870 MW. It is understood that the work is already in progress and the unit is likely to be commissioned during the period 1997-2002.

ii. *Wanakbori Thermal Power Station*

At Wanakbori, six units of 210 MW each are already under operation and now it is proposed to add the seventh unit of 210 MW during the ninth plan period. The total installed capacity at the power station would be 1470 MW. This unit is an extension at the existing stations where all infrastructure and coal linkage is available. The units will therefore have short gestation period.

iii. Gandhar gas based power station - 655 MW

At Gandhar in Baruch district of Gujarat a 655 MW gas based station is already existing. This is owned and operated by NTPC as a Central station. In order to meet the growing power demands of the state, Gujarat authorities have awarded implementation of a new project at PAGUTHAN (Gandhar) to Gujarat Torrent Energy Corpn. to install 655 MW additional capacity under state sector during the ninth plan period as an IPP project. It is understood that gas linkage for the project is currently under negotiation and it is expected that the power station would be commissioned during early ninth plan period.

iv. Pipavav gas based thermal station

The proposed Pipavav power station has been promoted by GPCL with an installed capacity of 655 MW at a cost of Rs 2100 crores would be located in Amreli district of Saurashtra region of Gujarat. This station would utilise the gas available from Gulf of Cambay and is programmed for commissioning by middle of 9th plan.

5.1.4 New identified generating projects

i. Private sector utility Ahmedabad Electricity Co. (AE Co.) (270 MW)

At present the utility has got 510 MW of derated installed capacity. The utility is meeting the load demands of Ahmedabad city and the area surrounding the city. During ninth plan period the utility proposes to augment its capacity by installing an additional one 120 MW coal based unit and a 150 MW Naphtha based power plant.

ii. Bhavnagar (Ghoga) Thermal Power Station - (375 MW)

During ninth plan period, three units of 125 MW each are proposed to be installed at Bhavnagar in Saurashtra region of Gujarat utilizing the lignite resources of the state at an estimated cost of Rs 175 crores for generating power at this station. The project has been promoted by Gujarat Power Corpn Ltd.

iii. Mangrol Thermal Power Station (250 MW)

To meet the increasing load demands of the state and by using the lignite resources of state, GPCL has promoted the project to install 2 units of 125 MW each at Mangrol, Surat at a cost of Rs 1103 crores. GIPCL would be implementing the project. The project is using environmental friendly technology to reduce the sulphur content of the lignite. The benefits from this project has been planned to be available during 9th plan period.

iv. GPCL gas based power station at Hazira - (160 MW)

GPCL propose to set up an 160 MW gas based station at Hazira during the 9th plan period which has been considered in the studies.

v. Jamnagar Thermal Power Station - (500 MW)

At Jamnagar in Saurashtra region of Gujarat, a refinery is being set up. Gujarat authorities have proposed to set up a petroleum coke based power plant to generate 500 MW of electric power. The project is proposed to be executed in the private sector by M/s Reliance Industries. The benefits from this station have been considered to be available during 9th plan.

vi. Chara/Sarkhdi gas based power station (600 MW)

At Chhara in Amreli district of Saurashtra region in Gujarat it has been proposed to add 600 MW of gas based power station to be executed by Gujarat Power Corporation Ltd., Ahmedabad. The gas for power station is proposed to be imported for which an LNG Terminal would be set up under a joint venture.

vii. Small power stations located at load centres - (600 MW)

In order to meet load demands incident on major grid substations, specially in Northern zone of the state, the state authorities have proposed to set up small size thermal units in size ranging from 15 MW to 100 MW aggregating to 1200 MW. Out of this for the present studies benefits to the extent of about 600 MW only have been considered during 9th plan. Keeping in view factors like short gestation periods involved and other techno-economic aspects like generation costs vis-a-vis transmission costs etc. The location, size and capacity of the proposed heavy oil based units is given in Table 1.

Table 1. Details of proposed small capacity power stations

Sl. No.	Location of power station	Name of district	Proposed capacity (MW)	Name of zone in which located
1	Dhansura	Sabar-Kantha	50	North
2	Idar	Sabar-Kantha	40	North
3	Vasana	Mehsana	50	North
4	Chattral	Mehsana	100	North
5	Kheralu	Mehsana	100	North
6	Siddhpur	Mehsana	50	North
7	Vadagam	Banas-Kantha	40	North
8	Deodar	Banas-Kantha	60	North
9	Ropar	Kutch	50	Kutch
10	Anjar	Kutch	50	Kutch
	Total installed capacity		590 MW	

viii. Barge Mounted Power Station (130 MW)

Gujarat has tremendous geographical advantage for port based power plants. To exploit this Gujarat authorities have proposed to install short gestation period seven Barge mounted power stations in Gujarat. Our preliminary studies however indicate that these stations will prove to be very costly. Power is required at the coastal stations throughout the year and its is not a seasonal load and as such there does not seem to be any advantage to meet these loads by Barge mounted stations in preference to fixed land based stations. Such Barge mounted stations were used in South America where they travelled along the Amazon river and supplied power to the river side paper mills by burning wood available in large quantities along the course of the river.

In the studies however two such plants - One 100 MW station at Mul Dwarka in Saurashtra and one 30 MW station at Dahej in South Gujarat have been considered and a final decision can be taken about its retention on the basis of the response to the tenders recently floated by Gujarat authorities. If found uneconomical these can be replaced by oil/gas based stations in the area.

ix. Akrimota Thermal Power Station - (250 MW)

A lignite based power station of 2 x 125 MW is being put up at Akrimota, Kutch. The first unit of this station is however expected to be commissioned in the 1st year of 10th plan.

5.15 Fuel-wise break-up

It would be interesting to know the breakdown of the total available capacity of 11831 MW at the end of 9th plan in terms of hydro, coal, lignite gas based and imported power. The following table summarize the position:

Table 2. Fuel-wise breakup of installed capacity by 31.3.2002

S No	Category	Available capacity	
		MW	Percentage of total
1	Coal based	3934	33
2	Lignite based	840	7
3	Hydro	547	5
4	Gas based	3179	27
5	Heavy Oil based	1230	10
6	Naphtha	150	1
7	Imported Power 1/c c.s.s and Joint Sector	1948*	17
	Total	11831	100

* includes availability of additional 245 MW of power from the Central Sector share of unallocated reserve.

It will be observed that the installed capacity in the state under coal based stations has reduced from 63% by 31.3.96 to 33% by 31.3.2002. However the installed capacity under gas and other petroleum based products has increased from 8% of total installed capacity by 31.3.96 to 38% of total installed capacity by 31.3.2002.

5.1.6 Unallocated share of central projects

At all the central generating stations, 15% of the installed capacity of the power station is kept as reserve by central government. For meeting the anticipated load demand of the utilities in the state, it has been assumed that 25% of the total unallocated central sector power stations in Western Region is supplied from Central Power Stations located in Western Region to Gujarat during emergencies which works out to about 245 MW. A provision has been made in the Transmission system to avail of this power for load generation balance studies.

5.1.7 Anticipated power supply position

To meet the anticipated peak load demand of 8647 MW by 31.3.2002, 5027 MW of installed capacity is proposed to be added thereby increasing the total installed capacity included Central/Joint Sector Share i.e. to 12174 MW. In addition 245 MW (25% of unallocated installed capacity reserve (975 MW) from Central Sector stations in Western Region) of power has been assumed to be available. However Dhuvran Thermal Station (588 MW) has been assumed to be not available for generating energy as all the units at the power station would be completing the 30 years average life of equipment. So the total installed capacity available for supplying power would be (12419-588) = 11831 MW. Assuming a peak meeting capacity of 73% of total installed capacity, 8637 MW of peak demand can be met. The energy available (as per assumptions indicated in the Table 4 below) would be surplus by about 14%. Table-3 below gives the anticipated power supply position at the end of ninth plan period (31.3.2002).

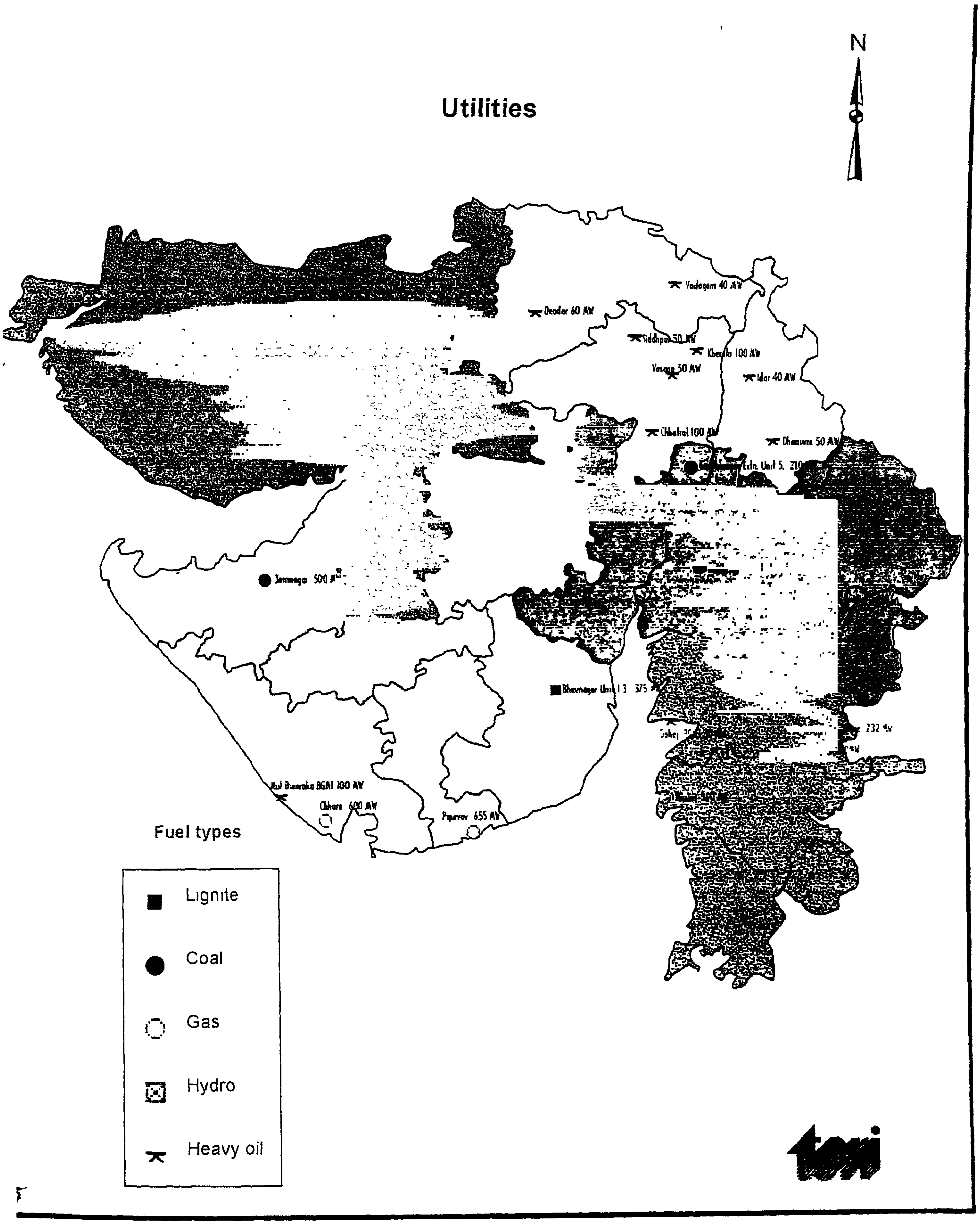
Table 3. Anticipated power supply position (Utilities) by the end of 9th plan (1997-2002) corresponding to proposed capacity expansion programme

Peak demand (forecast), MW	8640	Energy demand (forecasted), Mkwh	53781
Anticipated peak generation (available), MW	8637	Anticipated energy (available), Mkwh	61529*
Peak surplus (+)/deficit(-), MW	-003	Energy surplus(+)/deficit(-), Mkwh	7748
Peak surplus (+)/deficit(-), %	-	Energy surplus(+)/deficit(-), %	14.41

* as per assumptions indicated in Table 4 below.

Table 4. Assumptions for calculating the energy available at the bus

Type of fuel	Energy generated per MW per annum	Percentage auxiliary consumption (assumed)
Coal	5484	8.6
Lignite	5484	8.6
Hydro	3020	1.0
Gas	5000	2.5
Heavy oil	5000	2.5



Utilities

Proposed generating capacity additions during Ninth plan:1997-2002

Table A. List of proposed projects yielding benefits during 9th plan (1997-2002)

Sl. No.	Name of station	Nox size of unit	Fuel	Installed capacity (MW)	Ownership
	A. On going				
1	Sardar Sarovar (Guj share)		Hydro	232	Joint Sector
2	Vindhyachal (Guj share)		Coal	180	NTPC
	Sub total			412	
	B. Technically Approved				
3	Gandhinagar Extn, Unit 5	1x210	Coal	210	GEB
4	Wanakbori Extn Unit 7	1x210	Coal	210	GEB
5	Gandhar, Unit 1-4		Gas	655	GTEC
6	Pipavav		Gas	655	GPCL
	Sub total			1730	
	C. New Identified Schemes				
7	AECo., A'bad		Coal	120	IPP
8	Bhavnagar Unit 1-3	3x125	Lignite	375	GPCL
9	Mangrol Unit 1-2	2x125	Lignite	250	GPCL
10	Chhara/Sarakhdi		Gas	600	GPCL
11	Hazira		Gas	160	GPCL
12	AECo., A'bad		Naphtha	150	IPP
13	Jamnagar by Reliance		Petro Coke/HO	500	IPP
14	Small Power Stations near S/S		Heavy Oil	600	GEB
15	Barge mounted stations	1x100+1x30	Heavy Oil	130	GEB
	Sub total			2885	
	Total I.C.			5027	
16	Unallocated share			245	Central sector

5.2 Generation capacity addition programm during Tenth plan period (2002-07)

Introduction

For meeting the forecasted load demand of 12874 MW for Gujarat in the time horizon of 2002-07, a feasible-cum-desirable capacity addition program has been drawn up keeping in view consideration of availability of power from the advance action schemes in 9th plan which are expected to yield benefits in 10th plan, assessment of suitability of new schemes identified at the state level as well as at the central government level from considerations of gestation periods involved, fuel resources availability in the particular time frame, transportation constraints etc. The program envisages the commissioning of generation capacities during the tenth plan comprising the following:

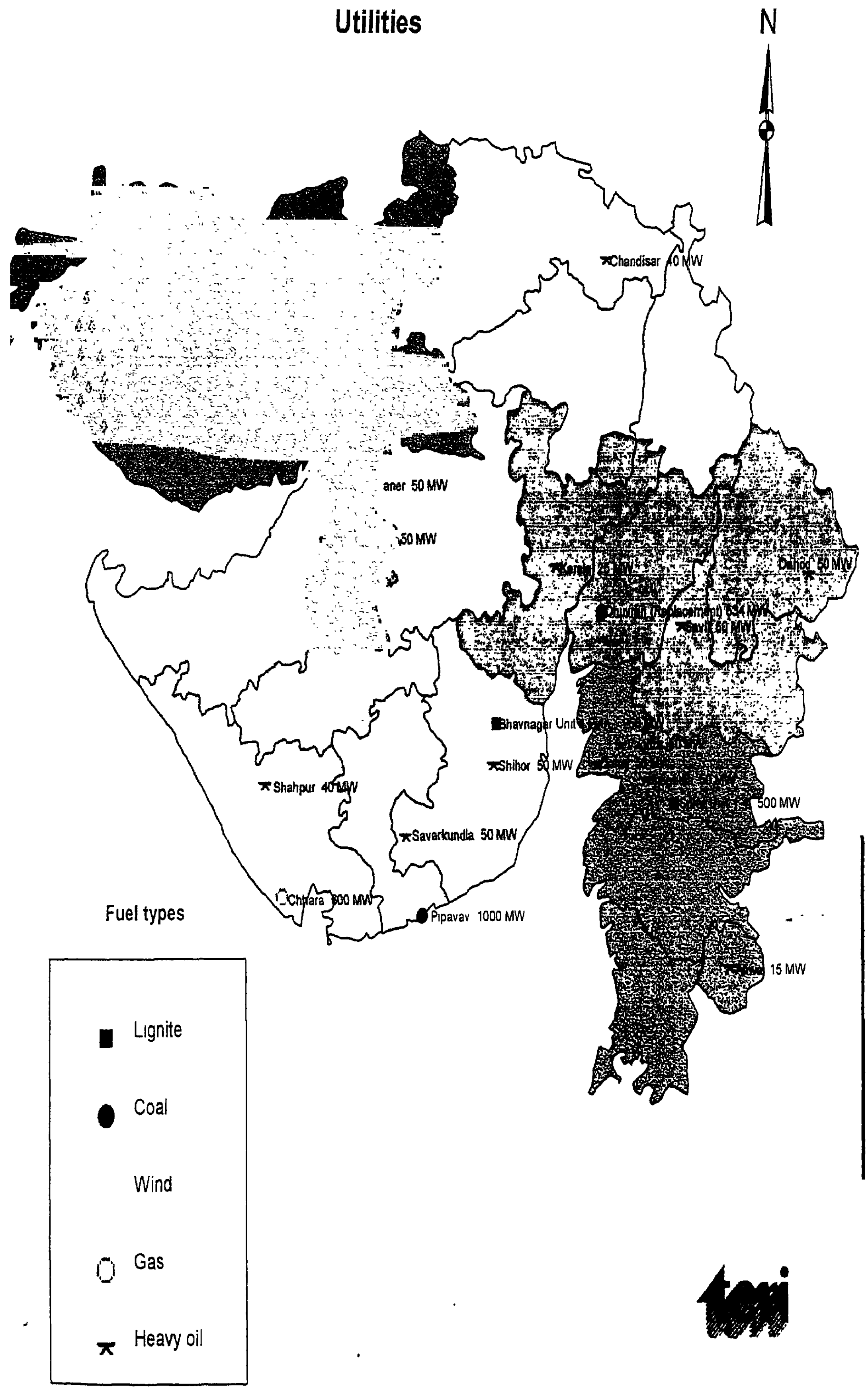
		MW
1.	Benefits from advance action projects taken up in 9th plan yielding benefits in 10th plan (2002-2007)	4620
2.	New identified schemes taken up in 10th plan and yielding benefits in 10th plan (2002-2007)	2144
		6764

The program excludes projects with an aggregated installed capacity of 4710 MW on which advance action has to be continued/initiated in 10th plan for commissioning in early years of 11th plan (2007-12).

5.2 Generation capacity expansion program during tenth plan (2002-07) period

5.2.2 Generation availability

The envisaged capacity addition of 6764 during 2002/07 MW comprises of 3854 MW of indigenous coal/lignite based stations, 1000 MW of imported coal based station, 610 MW of Heavy oil based small power stations, 600 MW of gas based stations, 500 MW of nuclear and 200 MW of wind power stations. For purposes of the generation planning exercise the existing four units of 120 MW each - two at Gandhi Nagar and two at UKAI Thermal Power Stations have been assumed to be retired since these units would be completing minimum of 30 years



Proposed generating capacity additions during Tenth plan: 2002-2007

of operation during the tenth plan period. However 588 MW (6 nos steam and 2 nos gas units) existing capacity at Dhuvran Thermal Power station which has been proposed to be retired during ninth plan period has been assumed to be replaced with new coal based units having aggregate capacity of 534 MW in a phased manner during the tenth plan period since coal linkage for this power stationwise would be existing. The station wise list of installed capacity addition during tenth plan is given in the table below.

Table 1. List of proposed projects during 10th plan (2002-2007)

Sl. No.	Name of station	Nox Size of unit	Fuel type	Installed capacity (MW)	Ownership
A.	**NINTH PLAN ADVANCE ACTION SCHEMES YIELDING BENEFITS IN 10TH PLAN - ON GOING**				
1	Akrimota TPS Unit 1-2	2 x 125	Lignite	250	GMDC
2	Bhavnagar TPS Unit 4 Extn	1 X 250	Lignite	250	GPCL
3	Surat TPS Unit 1-4	4 x 125	Lignite	500	GEB
4	Pipavav TPS	2 x 500	Coal	1000	GPCL
5	Import from CEPA, STPP, Unit 1-2	2 x 660	Coal	1320	IPP/PGCL sponsors
6	Chhara/Sarakhdi TPS	NA	Gas	600	GPCL
7	Import from SIPAT STPP in MP Unit-1	1 x 500	Coal	500	IPP/NTPC
8	Wind project	NA	Wind	200	IPP
B	**NEW IDENTIFIED SCHEMES**				
1	Mundra TPS	2 x 250	Coal	500	GPCL
2	Tarapur Extn	1 x 500	Nuclear	500	NPC
3	Replacement Dhuvran TPS	4 x 63.5 2 x 140	Coal	534	GEB
4	Small power stations	As per details	Heavy oil	610	GEB
	Sub total A			**4620 MW**	
	Sub total B			**2144 MW**	
	Total additions in installed capacity			**6764 MW**	

Further the following is the list of projects on which advance action has to be initiated in 10th plan for yielding benefits in 11th plan.

Table 2. List of projects requiring advance action during tenth plan yielding benefits during Eleventh Plan.

Sl. No.	Name of power station	Installed capacity (MW)	Type of fuel	Ownership
1	Gujarat West Coast TPS at Utran Ext.	500	Coal	GEB
2	Bhavnagar TPS Extension U-5	250	Lignite	GPCL
3	Mundra TPS U-3,4	500	Coal	GPCL
4	Import from CEPA U-3	660	Coal	IPP
5	Import from Sipat STPP U-3-5	1000	Coal	IPP/NTPC
6	Import from Parvati H E P	500	Hydro	IPP/NHPC
7	Tidal Power	900	Tidal	IPP
8	Solar Power	400	Solar	IPP
	Total	**4710**		

5.2.3 Brief details in respect of the projects included in the capacity addition program are discussed below.

5.2.4 Ongoing schemes

i. Akrimota Thermal Power Station - 250 MW

At Akrimota in Kutch region of Gujarat, it has been proposed to install two units of 125 MW each lignite based power station utilizing the lignite resources available in the state. It is understood that the project is proposed to be executed by Gujarat Mineral Development Corporation Ltd. (GMDC).

ii. Bhavnagar Thermal Power Station - Extension 250 MW

At Bhavnagar in Saurashtra region of Gujarat, 3 units of 125 MW each lignite based power station has been proposed during ninth plan period. During tenth plan it is proposed to install another unit of 250 MW as an extension work at Bhavnagar since the infrastructure for extension units would already be available. This work also is proposed to be executed by Gujarat Power Corpn. Ltd. (GPCL).

iii. Surat Thermal Power Station - 500 MW

Surat in southern region of Gujarat is one of the larger industrial townships of Gujarat. During tenth plan it has been proposed to set up a lignite based thermal power station with four units of 125 MW each. The lignite required for the power station would be available in the state. As discussed in para 4.3.4, use of lignite locally available for power generation would save on transport cost associated with coal. The project is proposed to be executed by Gujarat State Electricity Board (GEB).

iv. Pipavav Thermal Power Station Stage II

During ninth plan a gas based power station with 655 MW installed capacity has been proposed at Pipavav in Saurashtra region of Gujarat. As discussed in Para 4.4, this station could be operated on imported LNG. Since basic infrastructure at Pipavav would be available in 9th plan, it is proposed to add 1000 MW of thermal capacity addition under Stage II with imported coal blended with indigenous coal as fuel.

v. Power from CEPA's Thermal Power Station located in Orissa

As already discussed in para 4.7 Gujarat would be required to import large blocks of power based on coal from neighboring regions. In this context in the present exercise a private sector project under active consideration of Gujarat, Rajasthan, M.P. govt. etc. have been considered at IB valley in Orissa where a pit heat coal based station has been proposed to be set up by CEPA a Hongkong based company. It is understood that negotiations between CEPA and Govt. of Gujarat and others are going on for supply of power to be generated by them. It has been assumed that two of its units of 660 MW each would be available for Gujarat. For these studies transmission of power from that power station to Gujarat has been assumed over HVDC lines for economical reasons. The power from CEPA is planned to be received at a 400 kV substation in Central Gujarat for further distribution in the state over the existing transmission system.

vi. Chharra/Sarakhadi gas based thermal station Stage II - 600 MW

During the ninth plan, 600 MW gas based station has been proposed to be set up at Chhara/Sarakhadi in Saurashtra region of the state. It is proposed to expand the capacity by another 600 MW gas based station at the same site during tenth plan period since the infrastructure of setting up the second stage would be available. The project is proposed to be executed by Gujarat Power Corpn. Ltd. (GPCL).

vii. Share from Joint sector Thermal Power Station at SIPAT in M.P.

At SIPAT in Bilaspur district of Madhya Pradesh, NTPC in association with an IPP, has proposed to install a 2000 MW (4 x 500 MW) super thermal power station, under stage-I and further add 1000 MW (2 x 500 MW) under stage-II. It has been assumed that full power output from unit, 1,3 and 5 would be available for Gujarat. The gazette notification for the super thermal power station under Section 29(2) of the Indian Electricity Supply Act 1948 has already been issued by NTPC. During 10th plan one unit of 500 MW has been considered to be available for Gujarat to meet the load demand under utilities. This 500 MW power is expected to be supplied to Gujarat by displacement.

viii. Wind Project - 200 MW

Gujarat has long coastal boundary of about 1600 kms. In order to harness the non conventional and renewable energy resources of the state, it is proposed to harness 200 MW of wind power out of the total identified potential of 5000 MW. The wind power technology is clean and eco-friendly. The project is proposed to be executed by Independent Power Producers (IPP).

5.2.5 New identified schemes

ix. MUNDRA Thermal Power Station - 500 MW

At MUNDRA port in Kutch area of Gujarat, it is proposed to install a 500 MW imported coal based power station. which it is understood would be executed by Gujarat Power Corp. Ltd. (GPCL). As recommended in para 4.3.1, it would be advantageous for this power station to use a suitable blend of imported and indigenous E grade coal giving a calorific value of 4500-4800 kcal/kg. This will help in effecting economies in coal consumption and transport charges.

x. Tarapur Nuclear Power Station - Extension (500 MW)

At Tarapur in Maharashtra, two units of 160 MW are already in operation in which Gujarat has 50% share. Under central sector programme, NPC propose to install two units of 500 MW each as extension units, out of which Gujarat's share would be 500 MW.

xi. Replacement of coal fired units of Dhuvaran Thermal Power Station - 534 MW

As already indicated all the existing 8 units. (6 No.coal fired and 2 nos. gas fired) aggregate capacity 588 MW at Dhuvaran Thermal Station would be due for retirement during the course of 9th plan period. Provision has been made for replacement of the coal-fired units in the capacity addition program for 10th plan by making allowance for equivalent capacity (534 MW) in the system. Since GEB is the present owner of Dhuvran Power Station, it has been proposed that this replacement would be carried out by them.

xii. Small power stations located at Load Centres - 600 MW

In order to meet load demand incident on major grid station, the state authorities have proposed to set up small sized thermal units ranging from 15 MW to 100 MW aggregating to 1200 MW. Out of this 590 MW power stations have been proposed to be available during 9th plan and balance 610 MW capacity is proposed to be located at stations is indicated in the table below. It has been proposed to use heavy oil for operating these stations.

Table 3. List of small power stations

Sl. No.	Location of power station	Approx Capacity MW	District
1	Chandisar	40	Banaskantha
2	Shihor	50	Bhavnagar
3	Savarkundla	50	Bhavnagar
4	Shaper	50	Rajkot
5	Wankaner	50	Rajkot
6	Dasalpur	40	Kutch
7	Waghra	50	Bharuch
8	Jhagadia	50	Bharuch
9	Dahej	50	Bharuch
10	Savli	50	Vadodra
11	Shahpur	40	Junagadh
12	Kerala	25	Ahmedabad
14	Dahod	50	Panchmahal
	Total	**610 MW**	

5.2.6 Anticipated Power Supply Position by 31.3.2007

With the addition of the above mentioned generating stations during the tenth plan period, the total installed capacity (utilities) by 31.3.2007, is estimated to be 18,350 MW. Out of this 480

MW of installed capacity has been proposed to be retired, so the net installed capacity available would be 17870 MW by 31.3.2007 to meet the anticipated peak demand of 12860 MW. Table below indicates the anticipated peak and energy status by 31.3.2007.

Table 4. Anticipated power supply position (Utilities) by the end of 10th plan (2002-2007) corresponding to proposed capacity expansion programme

Peak demand (forecast), MW	12860	Energy demand (forecast), Mkwh	79976
Anticipated peak generation (available), MW	12800	Anticipated energy generation (available), mkwh	95871
Peak surplus (+)/deficit(-), MW	39	Energy surplus (+)/deficit(-), Mkwh	15895
Peak surplus(+)/deficit(-), %	0.26	Energy surplus(+)/deficit(-), %	19.87

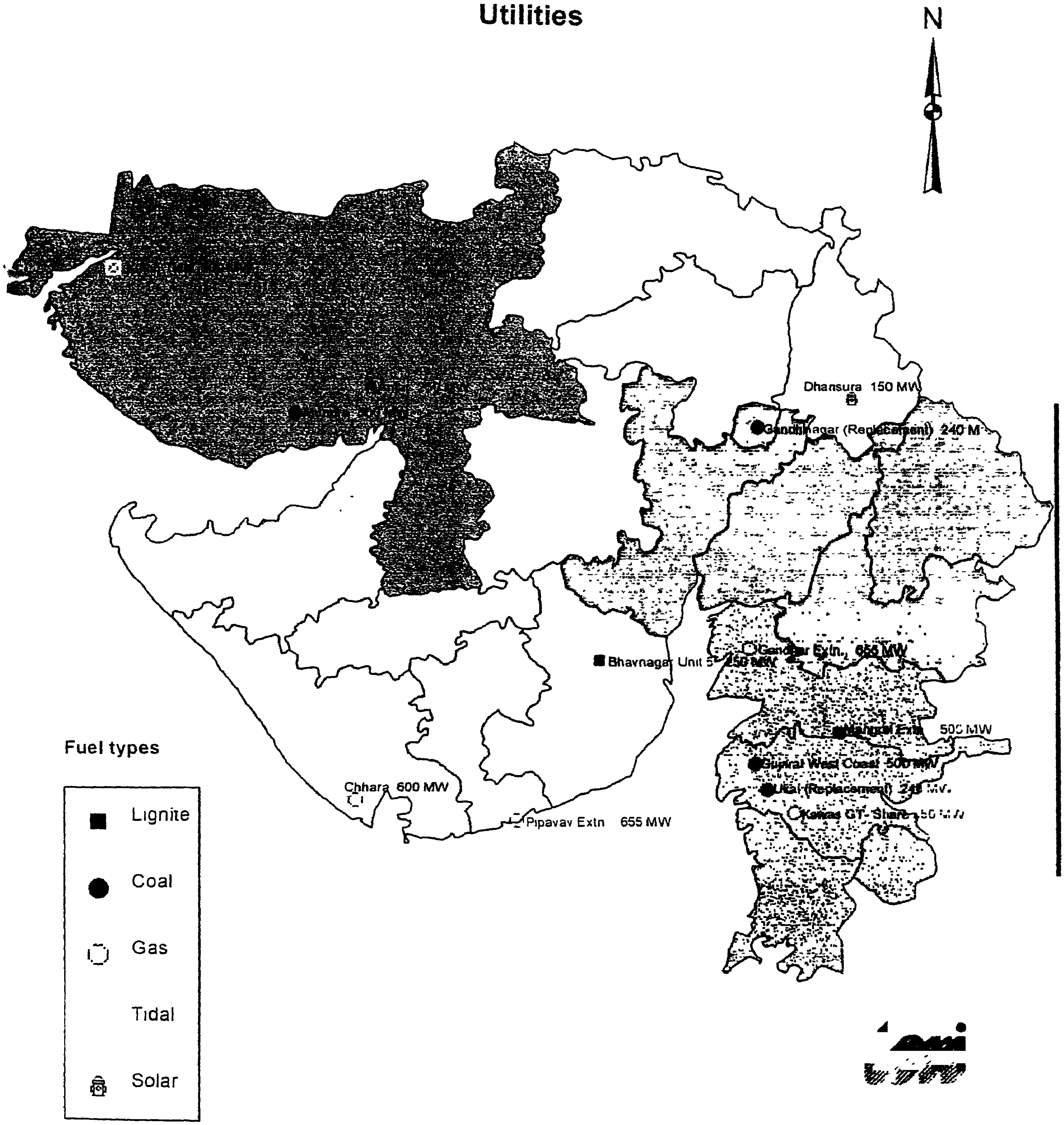
* As per assumptions indicated in Table 4 on page 65

It will be observed that the state would be experiencing marginal peak surplus of about 0.26%, and the energy would be surplus to the need of state by about 19.87%.

5.2.7 Further Table 5 below gives fuel wise break up of anticipated installed capacity (utilities only) of 17,863 by the end of tenth plan period i.e. 31.3.2007.

Table 5. Fuel-wise break of anticipated installed capacity by 31.3.2007

Sl No.	Type of fuel	Installed Capacity	
		MW	Percentage of total
1	Coal	5488	31
2	Lignite	1840	10
3	Hydro	547	3
4	Gas	3789	21
5	Heavy oil	1830	10
6	Naphtha	150	1
7	Wind	200	1
8	Import of power/central stations share/Joint project	4025	23
	Total	17870	100



Proposed generating capacity additions during Eleventh plan: 2007-2012

5.3 Generation capacity expansion program during Eleventh Plan (2007-12)

To meet the anticipated peak demand (utilities only) of 17872 MW by the end of Eleventh plan (2007-2012), it has been proposed to add 8250 MW of generating capacity during 11th plan period. This addition comprises of the following:

Table 1. Fuel wise additions in installed capacity during 2007-12

Sl. No.	Type of fuel	Installed capacity MW
	A State Sector	
1	Coal based thermal stations	1480
2	Lignite based thermal stations	750
3	Gas based thermal stations	2560
4	Non Conventional Energy Sources	
	(a) Tidal power plants	900
	(b) Solar power plants	400
	Sub total	6090
	B Joint/Central sector	
1	Coal based thermal station	1660
2	Hydro electric station	500
	Subtotal	**2160**
	Total addition	8250

Table-2 indicates station-wise list of proposed generating capacity additions during Eleventh Plan period (2007-12).

Table 2. List of proposed power projects yielding benefits during 11th plan (2207-2012)

Sl. No	Name of station	No x Size of unit	Fuel	Installed capacity (MW)	Ownership
I	**ON GOING SCHEMES**				
	A STATE SECTOR				
1	Bhavnagar TPS Ext U-5	250 MW	Lignite	250	GPCL
2	Gujarat West Coast TPS at Utran	2 x 250 MW	Coal	500	GEB
3	Mundra TPS U-3-4	2 x 250 MW	Coal	500	GPCL
4	Tidal power plants	-	Tidal	900	GEB
5	Solar power plants	-	Solar	400	GPCL
	B JOINT/CENTRAL SECTOR				
6	SIPAT STPP (Gujarat share)	2 x 500 MW	Coal	1000	Joint sector/IPP
7	IB Valley STPP by CEPA	1 x 660 MW	Coal	660	Joint sector/IPP
8	Parvati Valley HEP	-	Hydro	500	
	Sub Total (On Going)			**4710 MW**	
II	**NEW IDENTIFIED SCHEMES**				
	A STATE SECTOR				
1	Gandhar TPS Extn	-	Gas	655	GTEC
2	Mangrol TPS Extn	2 x 250 MW	Lignite	500	GIPCL
3	Pipavav TPS Stage II	-	Gas	655	GPCL
4	Charra TPS Stage III	-	Gas	600	GPCL
5	Kawas TPS Stage II	-	Gas	650	GPCL
6	Replacements of retd units at UKAI (240 MW) and Gandhinagar (240 MW)	4 x 120	Coal	480	GEB
	Sub total			**3540 MW**	
	Total additions during Eleventh plan (2007-12)			**8250 MW**	

It would be seen that about 57% of the additions in installed capacity is from ongoing projects and balance from new identified projects. For yielding benefits during Eleventh plan period it is stressed that some advance action has to be under taken on the projects termed under 'ON GOING SCHEMES' during the previous plan periods i.e. 1997-2007. Brief details of the proposed projects is discussed below.

5.3.1 On going schemes

i. Bhavnagar Thermal Power Station Extension - 250 MW

The Gujarat Power Corpn. Ltd. is proposed to be entrusted with the setting up a lignite based power station of 375 MW capacity at Bhavanagar in Saurashtra region during the period 1997-02. An extension of 250 MW capacity during the 10th plan period (2002-07) has also been proposed at this power station. During eleventh plan (2007-12) another extension of 250 MW lignite based units at Bhavnagar has also been proposed. This will utilize the lignite resources available in state. This extension project is also proposed to be executed by GPCL.

ii. Gujarat west coast Utran power station Ext. - 500 MW

In order to utilize the port facilities available along the western coast of the state and coal resources available in Madhya Pradesh, it has been proposed to install a joint sector coal based station at Utran in South zone of Gujarat.

iii. 500 MW Thermal Station at Mundra

At Mundra in Kutch region of Gujarat, a 500 MW coal based power station has already been proposed during the tenth plan period. During Eleventh plan period another 500 MW coal based power station has been proposed as an extension of the earlier project. The project is proposed to be executed by Gujarat Power Corp Ltd.

iv. Tidal power - 900 MW

As already stated in Chapter 5, the state has large tidal potential for generating power along its long coastline of 1600 km. It is purposed to harness this energy and install 900 MW of generating capacity from tidal power plants located in Kutch area during eleventh plan period. This project is proposed to be executed by GEB.

v. Solar Power Stations 400 MW

The Kutch and north areas of Gujarat have solar insolation of 5.8-6.0 kwh per sq.mt. per day. Therefore vast tracts of land in Banaskantha and Kutch districts of the state are ideally suited for tapping solar energy for generation of power. It is, therefore proposed to install 150 MW. Solar power station in Banaskantha and 250 MW solar power station in Kutch area during 11th plan period. These projects are proposed to be executed by Gujarat Power Corpn. Ltd.

vi. Extension of Thermal power station at SIPAT (M.P) - 1000 MW

In order to meet the increasing load demand, it has been proposed to increase the existing installed capacity of the proposed joint sector super thermal station at SIPAT in Bilaspur district of Madhya Pradesh to allocate additional 1000 MW of power to Gujarat. This power is also expected to be supplied to Gujarat by displacement.

vii. Power import from CEPA TPS - 660 MW

During tenth plan period two units of 660 MW each at coal based pit head power station in Ib valley of Orissa has been proposed. During eleventh plan it is proposed to add the 3rd unit of 660 MW capacity dedicated for Gujarat state. The project is proposed to be executed by CEPA.

viii. Parvati Valley H.E. Joint Project - 500 MW

In order to have a better hydro-thermal combination of power sources, it is proposed to have a joint sector hydro electric project plant in Himachal Pradesh with arrangements of supplying 500 MW of dedicated power to Gujarat. The power is proposed to be wheeled through dedicated transmission lines and injected into Gujarat grid.

5.3.2 New identified schemes

i. GANDHAR Thermal Power Station Extension - 655 MW

During the period 1997-02, 648 MW of gas based generating capacity has been proposed to be added. An 655 MW extension to above gas based project has been proposed to be set up during 11th plan period. The project is proposed to be executed by GPCL.

ii. Mangrol Thermal Power Station Extension - 500 MW

During ninth plan period (1997-02), a 250 MW lignite based power station has already been proposed to be set up by Gujarat Industrial Power Corpn.Ltd. at Mangnol in Surat (South zone) of Gujarat. During 11th plan period i.e. (2007-12), an extension of 500 MW has been proposed at Mangrol from the lignite resources available in the state. The extension is also proposed to executed by Gujarat Industrial development Corpn. Ltd.

iii. *Extension of Pipavav Thermal Power Station - 655 MW*

At Pipavav in Saurashtra region of Gujarat, a 655 gas based power station has already been proposed during ninth plan period (1997-02). During tenth plan period i.e. (2002-07), a 1000 MW imported coal based power station has also been proposed at Pipavav. Therefore, another 655 MW gas based power station has been proposed now during eleventh plan period. This project is also proposed to be executed by Gujarat Power Corpn. Ltd. (GPCL)

iv. *Charra gas based thermal power station stage III - 600 MW*

During ninth and tenth plan, stage I (600 MW) and Stage II (600 MW) of the project respectively has been proposed for implementation by GPCL. It has been proposed to expand this station to generate additional 600 MW as infrastructure for setting up the Stage III of the project would be available.

v. *Kawas gas based thermal power station StageII - 650 MW*

At Kawas in South region of Gujarat a 645 MW gas based thermal station is presently existing as a Central Sector station. It is proposed to install another gas based station of 500 MW capacity under state sector to be located near to existing thermal station to meet increased load demand during eleventh plan.

vi. *Replacement of retired units at UKAI and Gandhi Nagar - 480 MW*

During tenth plan period, it has been proposed to retire four units of 120 MW each two at Ukai TPS and two at Gandhinagar TPS. It has now been proposed to replace these four units by new units of both at Ukai and Gandhinagar Thermal power stations during eleventh plan period. The work is proposed to be executed out by Gujarat Electricity Board.

5.3.3 *Fuel-wise breakup of installed capacity*

The fuel wise breakup of installed capacity by the end of each plan would be as follows:

Table 3. Fuel-wise installed capacity by the end of each plan

S.N	Type of fuel	Present		8th plan		9th plan		10th plan		11th plan	
		31.3.1996		31.3.1997		31.3.2002		31.3.2007		31.32012	
		%	MW	%	MW	%	MW	%	MW	%	MW
1	Coal	63	3954	55	3954	33	3934	31	5489	25	6359
2	Lignite	2	140	3	215	7	840	10	1840	10	2590
3	Hydro	7	427	8	547	5	547	3	547	2	547
4	Naphtha	0	0	0	0	1	150	1	150	0.6	150
5	Heavy Oil	0	0	0	0	10	1230	10	1830	7	1830
6	Gas	8	473	16	1148	27	3179	22	3789	25	6349
7	Wind	0	0	0	0	0	0	1	200	0.8	200
8	Solar	0	0	0	0	0	0	0	0	1.6	400
9	Tidal	0	0	0	0	0	0	0	0	4	900
10	Central/Joint sector share	20	1293	18	1293	16	1951*	13	2205	9	2205
11	Imported power	0	0	0	0	0	0	10	1820	15	3980
	Total*	**100**	**6287**	**100**	**7157**	**100**	**11831**	**100**	**17870**	**100**	**25510**

* includes 245 MW from central unallocated power to balance the load.

From the above table, it is observed that the installed capacity in the state under coal based stations has reduced from 63% (by 31.3.1996) to 25% by 31.3.2012. However the installed capacity from state's own resources of lignite has increased from present (31.3.1996) 2% to 10% by 31.3.2012. Similarly the installed capacity from gas based stations of short gestation period has increased from present 8% to a high of 27% of total installed capacity by the end of ninth plan and 22% by the end of tenth and to 25% by the end of eleventh plan periods. Further effort has been made to utilize the non conventional energy resources of the state by increasing generation installed capacity of almost nil to a maximum of 6.4% by 31.3.2012. Moreover dependence of the state on import of power from the neighboring states including central sector share has been almost been varying between 16 to 24% of the total installed capacity during the three plan periods under consideration.

5.3.4 Anticipated power supply position

To meet the anticipated peak load demand of 17872 MW by 31.3.2012, 8250 MW of installed capacity is proposed to be added during the eleventh plan period thereby increasing the total installed capacity to 26120 MW. Out of this installed capacity, 610 MW of existing capacity (1 x 210 at wanakhori TPS and 2 x 200 MW at Ukai TPS) has been proposed to be retired as these units would be completing 30 years of operation. Therefore net installed capacity available by 31.3.2012; would be (26120-610) = 25510 MW (and 1500 MW not available for peak). Assuming a peak meeting capability as 73% of total installed capacity, 17527 MW of peak demand can be met. Table- 5 below indicates the anticipated power supply position (utilities only) at the end of eleventh plan period by 31.3.2012. Table 4 below indicates the anticipated power supply position of the state.

Table 4. Anticipated power supply position (Utilities) by the end of 11th plan (2007-2012) corresponding to proposed capacity expansion programme

Peak demand (forecast), MW	17872	Energy demand (forecast), Mkwh	111158
Anticipated peak generation (available), MW	17527	Anticipated energy (available), Mkwh	13221*
Peak surplus(+)/deficit(-), MW	- 335	Energy surplus(+)/deficit(-), Mkwh	97937
Peak surplus(+)/deficit(-), %	- 1.87	Energy surplus(+)/deficit(-), %	18.94

* As per assumption indicated in Table 4 on page 55

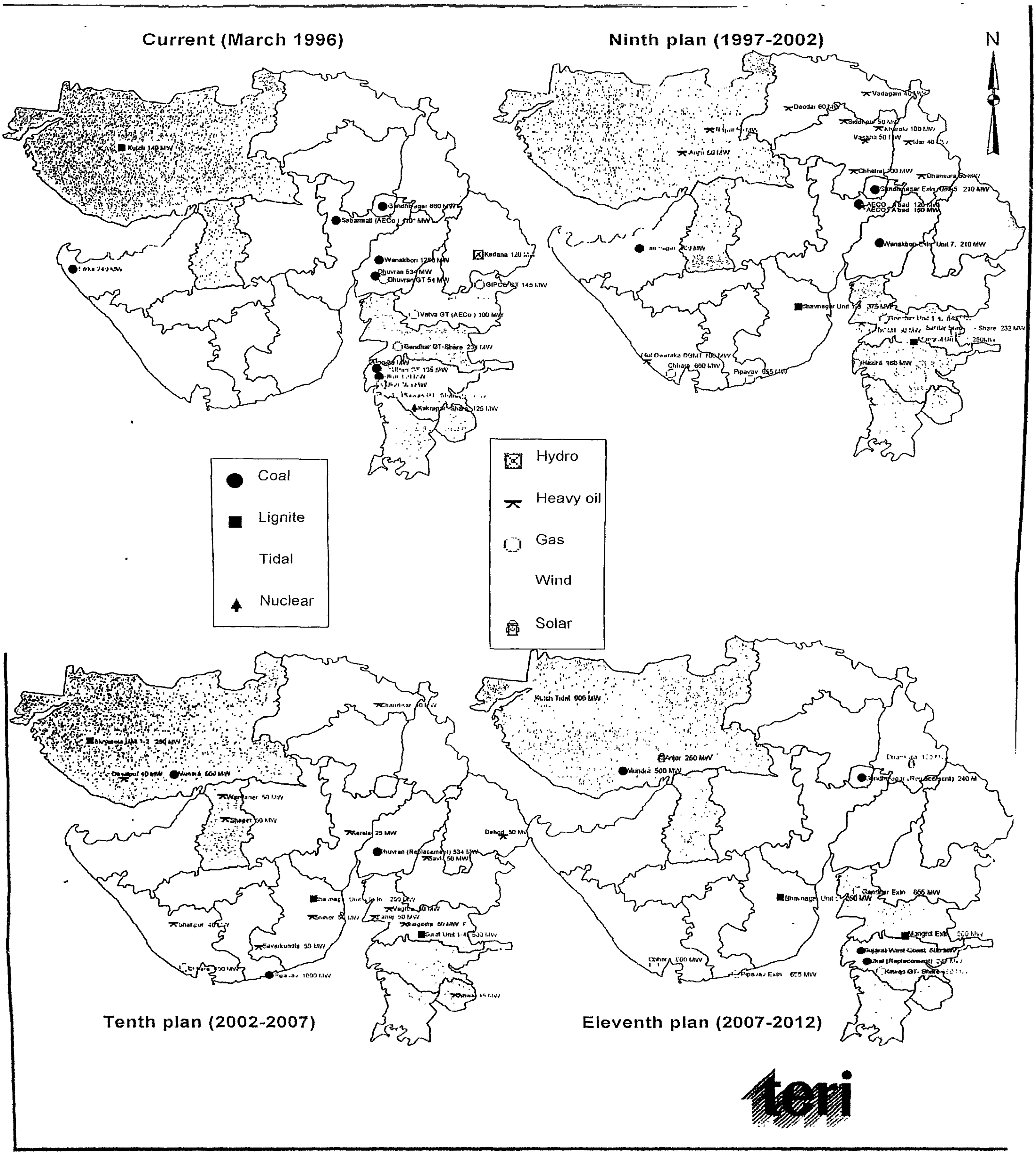
5.3.5 Planwise capacity addition programme

Table 5 below summarises the installed capacity addition programme during each of the five year plan periods.

Table 5. Capacity addition progammme

Type of plant	Ninth plan MW	Tenth plan-MW	Eleventh Plan-MW	Total MW
I Thermal				
1. Coal/lignite	1165	3034	2230	6429
2. Gas	2070	600	2560	5223
3. Others	1380	610	-	1980
II Non-Conventional Sources@	-	200	1300	1500
Power share from central/joint sector	412	2320	2160	4892
Total	5027	6764	8250	20024

@ capacity not available for peak demand



Generating capacity additions programme: 1997-2012

Annexure 5.1
Proposed generating capacity additions during 1996-2012

Projects	Type	Ownership	Capacity	Capacity at the end of year	Peak load supplied MW	Peak demand MW	Peak surplus / deficit MW %	Energy at the bus MU	Energy demand MU	Energy surplus/ deficit %
Total present IC capacity as on March 1996 (utilities)				6287	5245	6397	-18.01	33571	36895	-9.01
Capacity additions during 1996-97										
Kutch, Unit-3	Lignite	GEB	75							
Kadana Project, Stage-II	Hydro	GEB	120							
Baroda Extn.	Gas	GIPCL	160							
Essar Gujarat Power Plant, Unit 1-3	Gas	IPP	315							
Essar Gujarat Power Plant, Unit 1-4	Steam	IPP	200							
			870	7157	5225			37719		
9th Plan (1997-2002)										
AECo., A'bad	Heavy oil	IPP	150							
AECo., A'bad	Coal	IPP	120							
Bhavnagar Unit 1-3	Lignite	GPCL	375							
Chhara Sarakhdi	Gas	GPCL	600							
Gandhar Unit-4	Gas	GTEC	655							
Gandhinagar Extn, Unit-5	Coal	GEB	210							
Hazira	Gas	GPCL	160							
Jamnagar by reliance	Petro coke	IPP	500							
Mangrol Unit 1-2	Lignite	GIPCL	250							
Pipavav	Gas	GPCL	655							
Small Power Stations near s/s	Heavy oil	GEB	600							
Sardar Sarovar	Hydro	Joint sector	232							
Vindhyachal Stage II	Coal	NTPC	180							
Wanakbori Extn Unit-7	Coal	GEB	210							
Barge mounted stations	Heavy oil	GEB	130							
Additional share from CSS (unallocated)	Coal/gas	NTPC	245							
Retirement Dhuvran TPS				-588				-3068		
Total additions during the 9th plan			**5027**	**11831**	**8637**	**8640**	**-**	**61529**	**53781**	**14.41**

Annexure 5.1

Projects	Type	Owner-ship	Capacity	Capacity at the end of year	Peak load supplied MW	Peak demand MW	Peak surplus / deficit MW %	Energy at the bus MU	Energy demand MU	Energy surplus/ deficit %
10th Plan (2002-2007)										
Akrimota Unit 1-2	Lignite	GMDC	250							
Bhavnagar Unit-4 Extn	Lignite	GPCL	250							
Chhara/Sarakhdi	Gas	GPCL	600							
Mundra	Coal	GPCL	500							
Pipavav	Imported coal	GPCL	1000							
Replacement Dhuvran	Coal	GEB	534							
Surat Unit 1-4	Lignite	GEB	500							
Share from CEPA Unit 1-2	Coal	CEPA	1320							
Tarapur Extn.	Nuclear	NPC	500							
Wind project	Wind	GEB	200							
Small power stations near s/s	Heavy oil	GEB	600							
Sipat TPS	Coal	MP	500							
Retirement Ukai (2x120), G Nagar (2x120)				-480				-1415		
Total additions during the 10th plan			**6754**	**17870**	**12899**	**12860**	**0.26%**	**95871**	**79976**	**19.87**
11th Plan (2007-2012)										
Bhavnagar Unit 5	Lignite	GPCL	250							
Gandhar Extn.	Gas	GTEC	655							
Gujarat West Coast TPS	Coal	GEB	500							
Kutch tidal	Tidal	GEB	900							
Mundra	Coal	GPCL	500							
Sipat TPS	Coal	MP	1000							
Mangrol Extn.	Lignite	GIPCL	500							
Pipavav Extn.	Gas	GPCL	655							
Parbati Valley	Hydro	GEB	500							
Share from CEPA, Unit-3	Coal	CEPA	660							
Solar plant in Kutch	Solar	GPCL	400							
Replacement Ukai + G Nagar	Coal	GEB	480							
Kawas Extn. Stage II	Gas	GEB	650							
Chhara/ Sarakhdi	Gas	GPCL	600							
Retirement Wanakbori 210+ Ukai 400				-650				-2149		
Total additions during the 11th plan			**8250**	**25510**	**17527**	**17872**	**-1.87%**	**132212**	**111158**	**18.94**
Total likely additions during 9-11th plan			20024							

CHAPTER 6

Identification of transmission and requirements for the envisaged generation capacity expansion program

6.1 Introduction

The transmission system for evacuation for power from generating stations likely to be commissioned during IX, X and XI plans in Gujarat and transmitting to various load centers of the state has been developed generally in accordance with CEA Guidelines and Planning Philosophy issued in June 1994. Power flow studies have been carried out to ensure that the recommended transmission system has the necessary power evacuation capacity within permissible voltage regulation, line loadings, power loss and line outages.

The transmission network, as shown in Exhibit-I, will be overlaid on the existing network and will be so phased that it provides a minimum of redundancy of one line (n-1) outage in case of 400 kV system and D/C line (n-2) outage in case of 220 kV system while meeting the full power evacuation requirements. The expansion of network in the period 1997-2002 has to cater to evacuate and wheel an addition of 5027 MW followed by extension by 6284 MW in 2002-2007 period and further addition of 7640 MW in 2022-2012 period.

6.2 Evolution of system

Aim of the study is to evolve a perspective transmission plan for the state of Gujarat upto 2012 AD. As the system development is an evolutionary process it has to be ensured that the system development in the intermediate time frames also takes place without causing premature redundancies in the ultimate time frame. It has, therefore, become necessary to ensure that the systems in the intermediate time frames is evolved in such a way that they merge in to ultimate system development plans. One of the ways of achieving this is to work back from the ultimate system development plans to arrive at the system expansion plans in the intermediate time frame taking into account the present status of the system. In the present studies end of IX plan has been considered as base year as the generation and load picture for this period has been firmed up and end of X plan has been assumed as the intermediate time frame. After carrying out the studies for evolving the system for 2011-12 conditions, studies were repeated to arrive at the system for 2006-07 conditions. In this manner it has been ensured that the network development takes place in evolutionary manner from 2006-7 through 2011-12 without causing premature redundancy.

6.3 Generation capacity

The anticipated Installed capacity in Gujarat (as proposed) at the end of IX, X & XI five year plans would be 10112 MW. 16396 MW and 24036 MW respectively. In addition Gujarat would also be getting 1474 MW installed capacity as its share from existing/under construction Central Sector Generation. Details of Installed Capacity by the end of each plan under consideration are given in Annex-I.

6.4 Load demand

Load generation balance forms the basic input for any power flow study. The loads for the state as projected has been taken in these studies. Gujarat state has registered steady rise in plant load factor from 58.7% in 1990-91 to 65.6% in 1995-96. It is assumed that the trend would continue and PLF for 2001-2002 would be around 68%. The peaking availability for the whole state has, therefore, been considered as 73% i.e. 5% above the average PLF. For new power stations higher peaking availability has been taken as these power stations being in private sector, would operate at loading near to highest efficiency point i.e. where generation cost/MWh is minimum. It is to be noted that as per present day indications the private sector plants will be operating at a PLF much beyond contracted normative figure of 68%. The plant wise despatch taken in these studies is given in Annexures - 6.2.1 to 6.2.3

For the purpose of these studies, it has been assumed that the peak loads of all the sub-stations would occur at the same time, though in actual practice there will be distinct diversity. TERI has appreciated that growth has not been uniform throughout the state and some of the regions has been relatively more developed than others. Thus load growth in regions which are more developed is reaching saturation and future load growth would be more in comparatively less developed regions of the state. For breaking down the total projected loads in to sub-station wise loads, the state has been divided into five zones viz. Kutch, North Gujarat, Central Gujarat, South Gujarat and Saurashtra region. Most of the present day generation is in South and Central Zones. Load growth in these zones had, therefore, been higher than in other zones. It can be seen from Annex - 6.1 that most of additional generation would come up either in South Gujarat or in Sauratsra. It has been assumed that growth of load demand in these zones would be more than in north and central Gujarat. The growth for all the zones and the load projections have been broken down into substation wise estimates on the basis of the revised distribution pattern formulated in Chapter 1. Further all the loads connected to lower voltages have been lumped and considered to be incident at the corresponding 220 kV or 132 kV bus. The substation wise load projections are furnished in Annex - 6.3. The load power factor at 220/132 kV bus has been taken as .85

lagging. In the areas where the power factor is less than .85 it is assumed that sufficient reactive compensation would be provided by the concerned utility (GEB/AE CO etc) to bring the load power factor of .85 lagging at 220 kV/132 kV busses.

6.5 Generation despatch schedules

Generation despatch schedules corresponding to possible system operating conditions for testing the adequacy of transmission system evolved in the studies have been prepared. The norms for planned outages of generating units recommended in CEA's Manual on Transmission Planing Criteria - June 1994 (Relevant extracts of the CEA's Manual giving permissible loading limits, voltage limits and security standards are appended at Appendix - A) have been adopted. As regards the forced and partial outages of units, the same could be considered in a number of permutations and combinations. However, while determining the evacuation system for new generating projects/units, maximum probable generation from the concerned generation pocket have been considered to test system performance and extreme conditions of operation. Generation despatches under various operating conditions is given Annex - 6.2-1 to 6.2.-3.

6.6 Transmission network

In these studies, the transmission network at 220 kV and 400 kV has been fully represented. All the 132 kV lines required for evacuation of power from major power station has also been represented in the studies. The details of existing network including transmission line parameters considered in these studies are furnished in Annexures - 6.4.

6.7 Transmission system requirement during the period 1996-2002

The evacuation system required for individual power plant being commissioned during the identified period has been worked out as an overlaid system over existing network.

6.7.1 Transmission system required for power evacuation from generating stations likely to be commissioned during the period 1996-2002 in North & Central Gujarat

Following power stations are likely to be commissioned in North Gujarat during IX plan.

i)	Gandhi Nagar Extn (Unit 5)	1x210 MW
ii)	Wanak Bori Unit 7	1x210 MW
iii)	Kadana Extn	2x60 MW

Fig 1

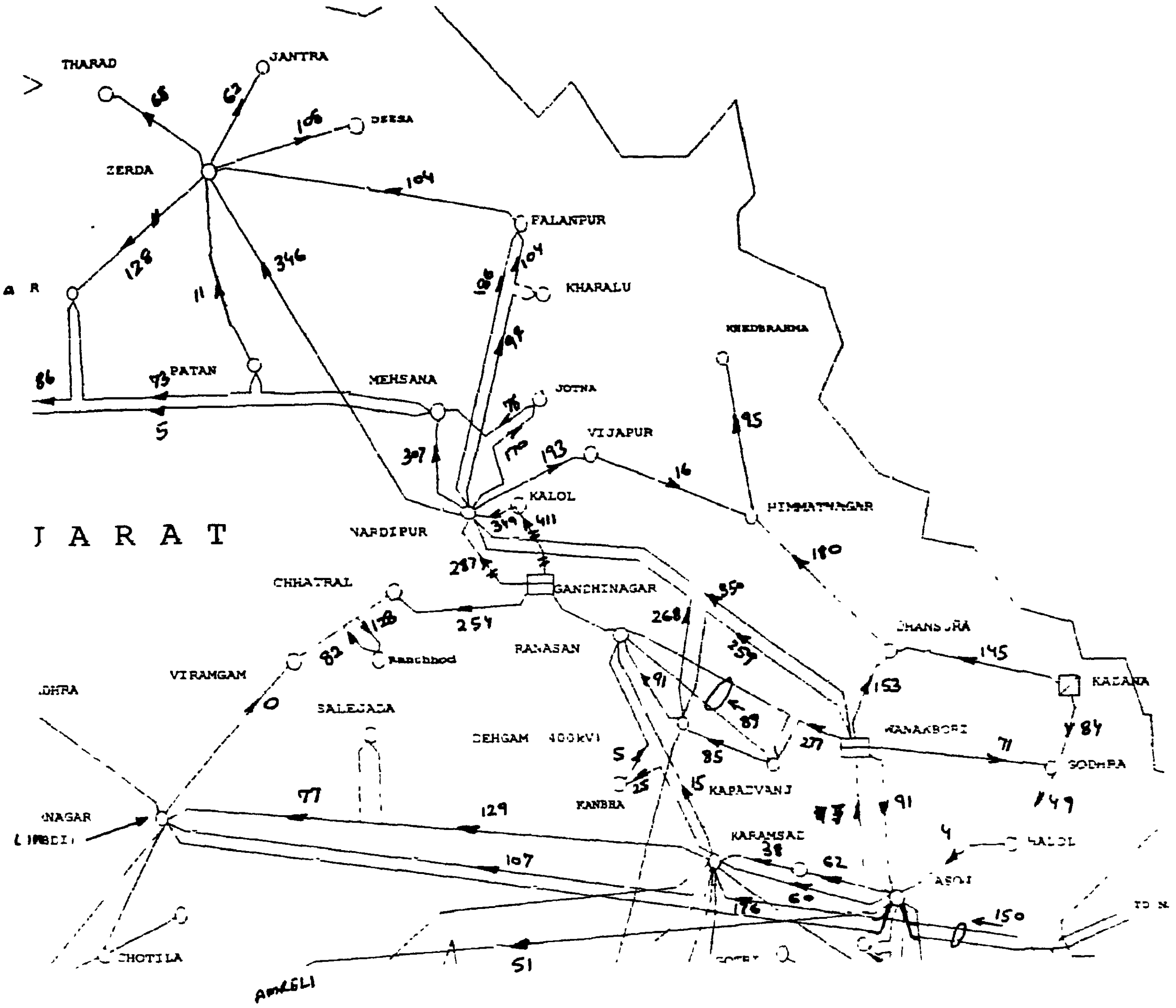
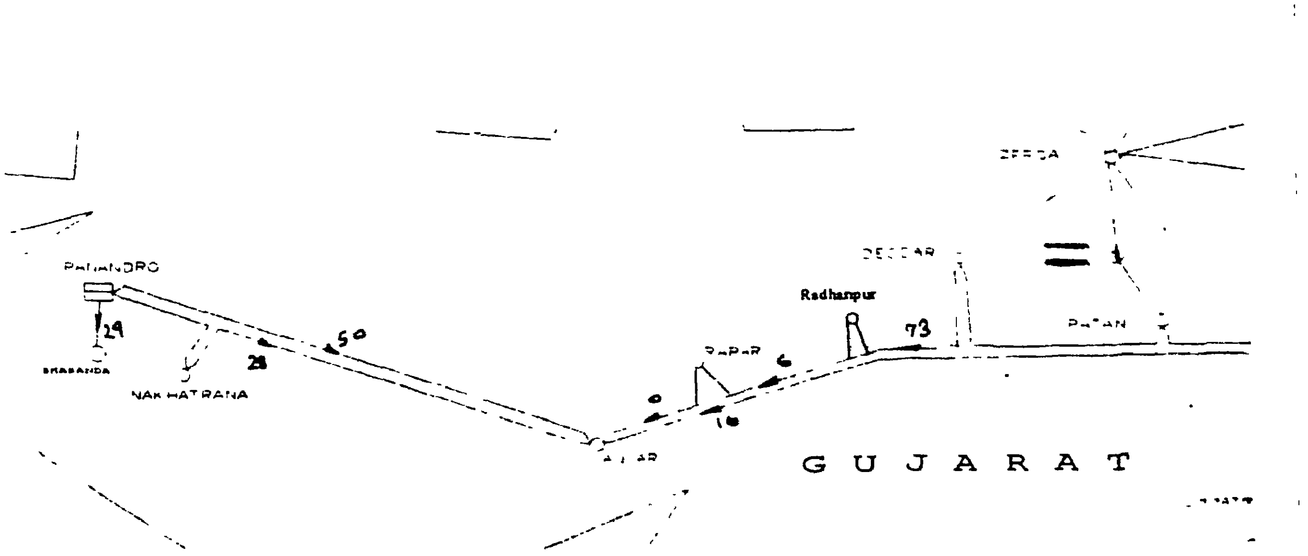

THARAD
JANTRA
DEESA
ZERDA
PALANPUR
DEODAR
KHARALU
KHEDBRAHMA
PATAN
MEHSANA
JOTNA
VIJAPUR
KALOL
NARDIPUR
HIMMATNAGAR
J A R A T
CHHATRAL
GANDHINAGAR
RANASAN
DHANSURA
VIRAMGAM
Ranchhod
SALEJADA
DEHGAM 400kV
WANAKBORI
KADANA
GODHRA
KANBHA
KAPADVANJ
NAGAR
LIMBDI
KARAMSAD
HALOL
ASOJ
CHOTILA
AMRELI
65
67
106
104
128
11
346
106
104
98
86
73
5
307
76
170
193
16
95
349
411
287
180
254
128
82
0
268
250
259
153
145
91
89
85
277
71
84
5
25
15
77
129
107
38
62
60
176
91
4
49
150
51

Fig 2


ZERDA
DEODAR
Radhanpur
PATAN
RAPAR
PANANDRO
NAKHATRANA
G U J A R A T
29
28
50
73
6
0
16

iv) Sabarmati (AE Co.) 1x150 + 1x120 MW

While determining transmission system requirement for these units it is assumed that none of the units at these power stations would be under planned/forced outage and maximum probable generation from these power stations, as given below, have been considered

Generating station	Installed capacity (MW)	Maximum Despatch assumed (MW)
Ghandhi Nagar	870	750
Wanak Bori	1470	1200
Kadana	240	230
AE Co.	780	700
Total	3360	2880

Evacuation system requirements for each of these stations is discussed, in detail, in ensuing paragraphs.

It may be noted that figures showing power flows are not to scale. Further, only relevant portion of Gujarat grid has been shown in figures. For connectivity now shown in these please refer Exhibit 2.

a) Gandhi Nagar Extn. (Unit 5) 1 x 210 MW

At present 3 units of 120 MW each and two units of 210 MW each are installed at Gandhi Nagar. Power from these units is being stepped up to 220 kV and evacuated at 220 kV through following transmission lines.

i) Gandhi Nagar - Ranasan 220 kV D/C
ii) Gandhi Nagar - Nardipur (Soja) 220 kV D/C
iii) Gandhi Nagar - Chhatral 220 kV D/C

In addition two 220 kV D/C lines between Ghandhi Nagar and Kalol (Jamla) and 220 kV D/C line between Kalol and Nardipur (Soja) are under construction. Results of these studies are shown in Fig. 1. From the perusal of the fig it can be seen that power flows on all lines remain within limits under normal conditions.

b) Wanakbori - Unit 7 (210 MW)

The evacuation system for this additional unit has already been firmed up by GEB in consultation with CEA and the same has been retained. The evacuation system overlaid in the existing network for Wanakbori unit 7 is as under

i) Wanakbori - Kapadwanj 220 kV D/C line

ii) Kapadwanj - Dehgam 220 kV D/C line

iii) Dehgam - ranasan 220 kV D/C line

The power flows with full generation from Wanakbori TPS is shown in Fig 1. From the figure it can be seen that loading on all 220 kV lines are well within limits. Loadings remain within limits under outage of highest loaded line. No additional Transmission lines would be required to evacuate power from this unit.

c) Kadana HEP extn (120 MW)

With the addition of 2 units of 60 MW each during 1996-97, total installed capacity at Kadana HEP would become 240 MW by the end of 8th Plan. To evacuate this power four 220 kV ckts are available. These are :

i) Kadana - Dhansura 220 kV D/C

ii) Kadana - Godhra - Halol - Asoj 220 kV D/C

Power flows with maximum power from Kadana HEP are also shown in Fig 1. From the figure it can be seen that power flows are well within limits.

d) Sabarmati TPS of AECo - 270 MW

AE Co Ahmedabad are installing Naptha based power station of 270 MW at Sabarmati. With the installation of this power station total installed capacity of AE Co would become 780 MW (Derated). It is proposed to step up this power at 132 kV and meet local AE Co loads in and around Ahmedabad city. Balance power, if any, from AE Co would be injected into grid at Ranasan. No new transmission system is proposed for this power station.

6.7.2 Transmission system required for evacuation of power from Generating Stations likely to be commissioned in Kutch Region during IX plan period

During IX plan only one unit of 75 MW is likely to be commissioned in this region which is spill over works of VIII plan. The evacuation system for this additional unit has already been firmed up by GEB in consultation with CEA and the same has been retained. The vacuation system overlaid in this existing network for this unit is as under.

i) LILO of one ckt of Kutch (Panandaro) - Anjar 220 kV D/C line at Nakharatna

ii) Kutch (Panandaro) - Bharanda 220 kV S/C line

Power flows with maximum power from Kutch is shown in Fig 2. From this it can be seen that power flows are well within limits. Outage of both ckts of 220 kv Kutch - Anjar line cannot be met with and as power station is situated at very remote place. N-2 redundancy as per CEA's new Planning Criteria, would be very expansive thus not provided.

In addition to above small thermal power stations of 50 MW each using heavy oil as fuel at Anjar & Rapar has also been envisaged to meet local requirements. It may be seen that with addition of these units in Kutch region, total peak load (218 MW) of the region balances net generation available (223 MW) and very small amount of power is left to be evacuated. Existing Mehsana - Anjar 220 kV D/C line would, thus, remain under loaded. It is proposed to LILO one circuit of this Line at Rapar to evacuate surplus power from Rapar after meeting local loads.

It may be pointed out that outage of Panandaro - Bharand and Anjar - Rapar 220 kV S/C lines have not been provided. In the event of outage of any of these lines loads of these areas can be met through underlying existing 132 and 66 kV networks.

However during detailed discussions held with Transmission planning group of GEB, in Nov, 97, it was informed by GEB that a 200 kV double circuit line between Nanighakhar and Morvi via Rapar is proposed to increase the stability of the Panandhro power station. This proposal is based on the results of the Transient stability studies carried out by GEB and the same has been accepted, as the Transient stability studies were not covered in the TERI's scope of work.

6.7.3 Transmission system required for evacuation of power from Sardar Sarovar HEP - 1450 MW

The evacuation system for this Hydro Electric Power Station - joint project of MP, Gujarat and Maharashtra has already been firmed up by CEA in consultation with constituent states. The evacuation system overlaid in the existing network for this HEP is as under

i) Sardar Sarovar - Asoj 400 kV D/C line (Gujarat)

ii) Sardar Sarovar- Nagda 400 kV D/C line (MP)

iii) Sardar Sarovar - Dhule 400 kV D/C line (Maharashtra)

Power flows with full share of Gujarat from Sardar Sarovar HEP is shown in Exhibit II. Although the power flows over Sardar Sarovar - Asoj 400 kV D/C is only 150 MW. This line has been retained as it is expected to be loaded during subsequent plans for supplying power by displacement from the proposed/planned pit head power stations in MP.

6.7.4 Transmission system required for evacuation of power from generating stations likely to be commissioned by the end of IX plan in South Gujarat

Following power stations are likely to be available during 1996-2002 period in South Gujarat

i) Gandhar (Paguthan) CCGT 655 MW

ii) Essar CCGT 515 MW

iii) Hazira CCGT 160 MW

iv) Mangrol TPS 2 x125 MW

v) Baroda (GIPCL) 160 MW

Where as Gandhar & Baroda units are located at upper reaches of south Gujarat, Essar, Hazira and Mangrol power stations are located in close proximity in southern portion of south Gujarat. It is therefore, thought prudent to determine transmission system requirement for these units it is assumed that none of the units at power stations in south Gujarat including central sector stations would be under planned/forced outage and maximum probable generation from these power stations, as given below, have been considered

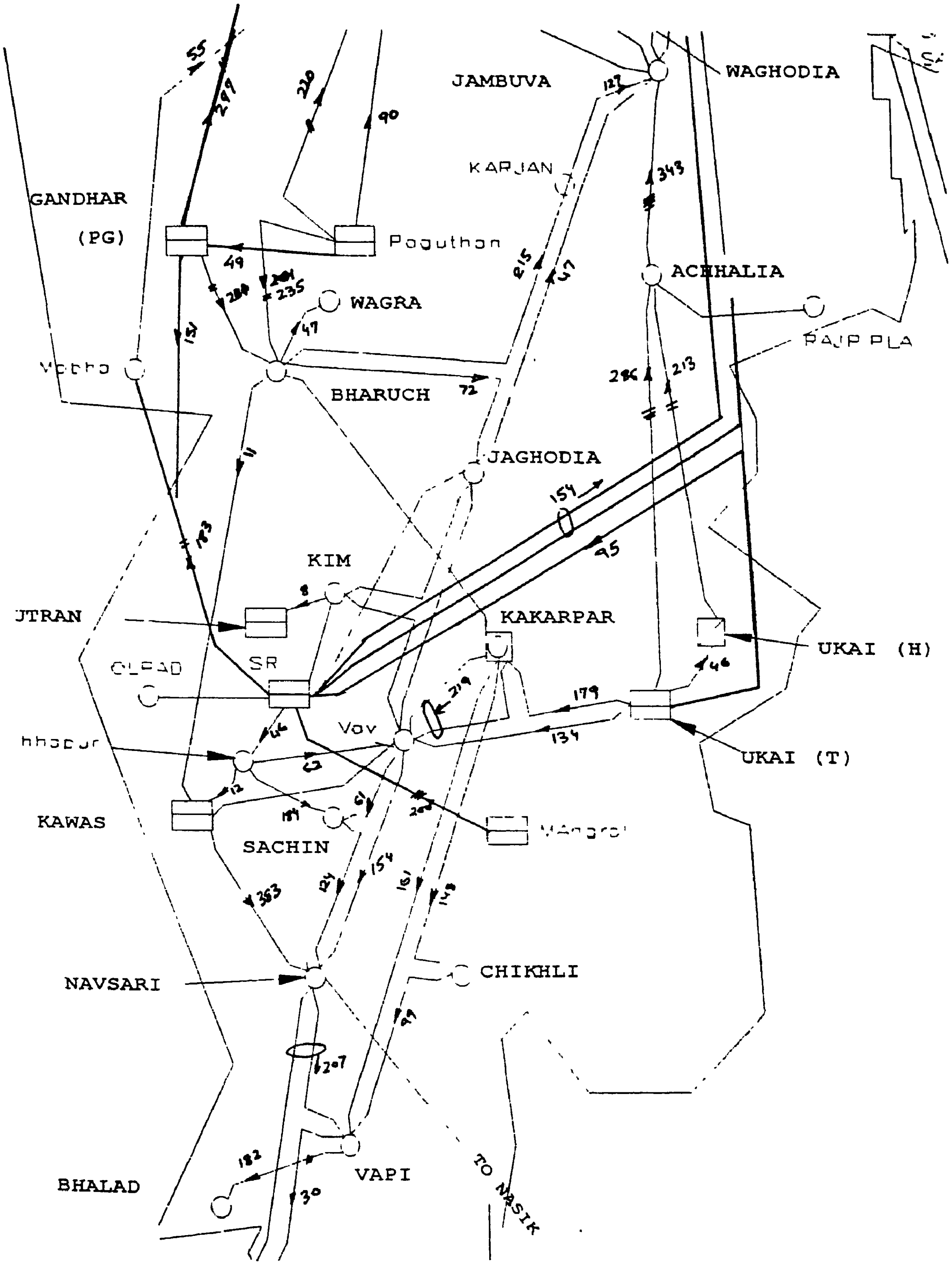
Generation station	Installed capacity (MW)	Maximum Despatch assumed (MW)
Gandhar (Paguthan)	655	600
Gandhar (NTPC)	648	600
Ukai (T)	850	740
Ukai (H)	305	225
Kawas	645	600
Kakarpar	440	350
Essar	675	600
Mangrol	250	200
Total	**4468**	**3915**

Total loads of South Gujarat including UTs of Dadar, Nagar Heveli and Daman & Diu would be around 2300 MW. With this generation of the order of 3900 MW about 1600 MW would be surplus in South Gujarat. To evacuate this power, following system is already available/under construction.

Line section	Present status
Gandhar (NTPC) - Dehgam 400 kV D/C line	Existing
Gadhar (Paguthan) - Karamsad 400 kV S/C	Under Const
Baruch - Jambua 220 kV D/C	Existing
Achhalia - Jambua 220 kV Q/C	Existing
Baruch - Karamsad 220 kV D/c	Existing

i.e. three 400 kV ckts along with eight 220 kV ckts would be available to evacuate surplus power of the order of 1600 MW from south Gujarat. Prima facie, these are sufficient and only small transmission links would be required to evacuate power from new power stations and to take it to existing load centers/pooling points in south Gujarat for further transmission to central Gujarat. Evacuation system from each of new station coming up in south Gujarat is discussed in detail as below:

Fig 3


JAMBUVA
WAGHODIA
55
299
220
90
127
KARJAN
343
GANDHAR
(PG)
Poguthan
49
284
235
WAGRA
47
215
47
ACHHALIA
RAJPIPLA
151
Vobho
BHARUCH
72
286
213
11
JAGHODIA
154
95
183
KIM
8
UTRAN
KAKARPAR
UKAI (H)
46
OLPAD
SR
179
219
Vav
134
UKAI (T)
Bhatpur
62
12
KAWAS
184
61
204
Mangrol
SACHIN
363
124
154
161
143
CHIKHLI
NAVSARI
99
207
182
30
VAPI
BHALAD
TO NASIK

a) Ghandhar (Paguthan) CCGT - (655 MW)

The power station is spill over works of VIII plan and following transmission system required to evacuate power has already been planned by GEB in consultation with CEA and is under construction.

i) Paguthan - Gandhar (NTPC) 400 kV S/C line

ii) LILO of Karamsad - Baruch 220 kV D/C at Paguthan

Power flows are shown in Exhibit II. From this exhibit, it can be seen that transmission system already provided is adequate and no additional transmission lines would be required to evacuate power from this power station.

b) Essar CCGT - 3x105 MW + 200 MW, Hazira CCGT - 160 MW & Mangrol TPS 2x125 MW

Essar project is one of the first projects coming up in the country after gates of power sector were thrown open for private sector participation. The project is situated at Hazira in South Gujarat near Surat (Kawas). Three gas turbines units of 105 MW each have already been commissioned during 1996-97 and a steam unit of 200 MW is also expected to be commissioned during the current year. At present power, after meeting the local requirement is being injected into the GEB grid at Ichhapur through Transmission system associated with Kawas CCGT of NTPC. This has resulted in overloading of Kawas Transmission system and, thereby, forced backdown of one unit at Hazira. Following lines are under construction to evacuate power from Essar CCGT.

i) LILO of one ckt of Vav - Navsar 220 kV D/C line at Sachin

ii) Essar - Sachin 200 kC D/C line

Even these would be inadequate to evacuate full power from Essar. Moreover, one additional unit of 160 MW is likely to be commissioned during IX plan period at Hazira and total installed capacity at Hazira would become 675 MW.

Mangrol TPS is also situated north of Surat and power is likely to be available from this station during 4th year of IX plan. As all the three power stations are located in close proximity it was considered prudent to determine transmission system requirement for all of them together.

Time frame for these power stations and future projects likely to be commissioned in the area were kept in mind while determining transmission requirement for these power stations. It has also been proposed to add about 1000 MW generation capacity in the south Gujarat area during X & XI plan period. These are

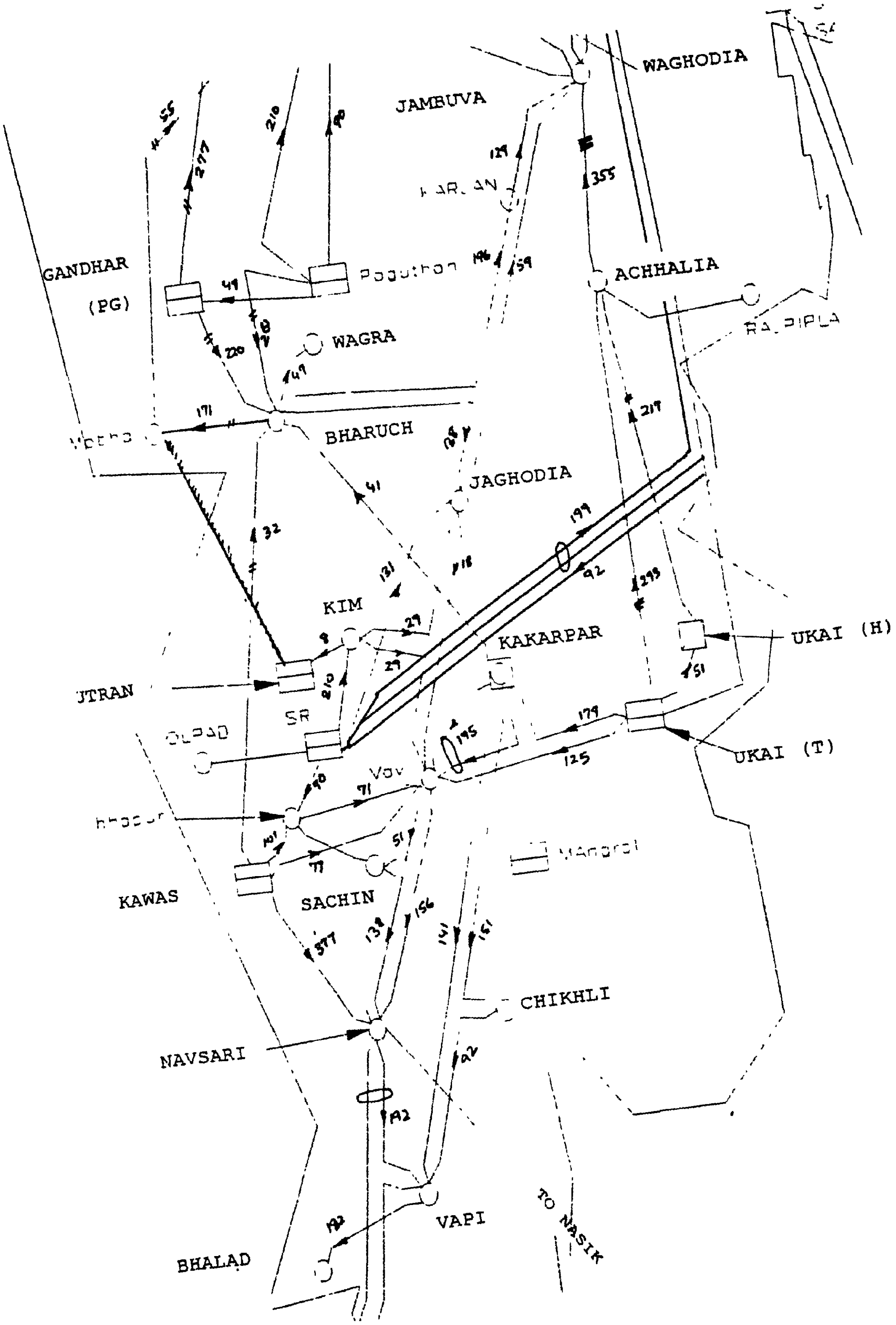
i)	Surat units 1-4	500 MW
ii)	TAPP Extn (Gujarat share)	500 MW
iii)	Gujarat West Coast	500 MW
iv)	Mangrol Extn.	500 MW

These units along with Essar and Mangrol form a cluster and are in same right of way, it is considered prudent to a create a power pool at/near the site of Essar P S (Kosambha) for further evacuation, to load centers in different parts of the state. Number of alternatives, including evacuation at 400 kV level were considered. Due to time frame of Essar & Mangrol projects, 400 kV option did not find favour. However, keeping in view the future expansions, it is proposed to construct a 400 kV D/C line between Essar and Navsari and charge it at 220 kV initially. 400 kV level can be created at Essar during X plan when additional generation at Surat and TAPP extn is made available. Detailed discussions on the alternatives studied and transmission system evolved is given below:

Following system was considered to start with:
LILO of Ukai (T) - Asoj 400 kV line at Essar
Essar - Asoj 400 kV S/C
Essar - Kim 220 kV D/C
Essar - Olpad 220 kV S/C
Essar - Jagodia 220 kV D/C
Mangrol - Essar 220 kV D/C
Mangrol - Essar 220 kV S/C
Essar - Mobha 220 kV D/C
Mobha - Karamsad 220 kV D/C

Power flows for this alternative are shown in Fig 3.

Fig 4


WAGHODIA
JAMBUVA
KARJAN
129
355
Poguthan
196
59
ACHHALIA
RAJPIPLA
GANDHAR
(PG)
55
277
210
90
49
220
18
WAGRA
149
171
Mobha
BHARUCH
128
JAGHODIA
41
32
219
199
92
131
118
295
KIM
8
29
29
KAKARPAR
UKAI (H)
51
JTRAN
210
SR
OLPAD
179
195
125
UKAI (T)
Vav
90
71
Bhestan
101
77
51
Mangrol
KAWAS
SACHIN
377
138
156
141
161
CHIKHLI
NAVSARI
92
192
VAPI
192
BHALAD
TO NASIK

On perusal of fig 3 it can be seen that Kawas - Navsari line is critically loaded and there are not enough margins on other lines to meet the outage of this line. It can also be seen Kawas - Baruch 220 kV D/C line was very much under loaded. As Baruch lies on the corridor of proposed Essar - Mobha 220 kV line it was considered to meet loads of Mobha from Baruch instead of Essar pooling point. The results of this alternative is plotted in Fig 4.

With the change suggested above loading of Kawas - Navsari line reduces, but still remained critically loaded under normal operating conditions indicating that strengthening is required towards Navsari/Vapi. Further, loading on Essar - Asoj two 400 kV lines was only of the order of 180 MW. Considering this meager loading of 400 kV lines and also the time frame of Essar, Hazira and Mangrol power stations, creation of 400 kV level at Essar pooling point was dropped and LILO of Ukai - Asoj line 400 kV at Essar alongwith another 400 kV Essar - Asoj S/C line was not considered. To reduce loading on Essar - Navsari section, a 220 kV D/C line between Essar and Navsari was added. Results of this alternative is plotted in Fig 5. On perusal of this fig it can be seen that loading of Kawas - Navsari lines is reduced and remains within limit. Loading of the new Essar - Navsari 220 kV D/C line is also within limits. Loading of all lines remain within limits even under outage of Kawas - Navsari 220 kV D/C line (fig 6). Considering the future expansion and with availability of power from TAPP extn it is suggested that Essar - Navsari D/C line should be constructed as a 400 kV line but, operated at 220 kV initially.

Fig 6 shows power flows on various transmission lines in the event of outage of Kawas - Navsari D/C lines. It will be observed that line flows are well within the limits.

To summarize following system is recommended for Essar and Mangrol Power Stations.

Mangrol - Essar 220 kV D/C

Mangrol - Essar 220 kV S/C

Essar - Kim 220 kV D/C

Essar - Olpad 220 kV S/C

Essar - Jagodia 220 kV D/C

Essar - Mobha 220 kV D/C

Mobha - Karamsad 220 kV D/C

Essar - Navsari 400 kV D/C (to be operated at 220 kV initially).

On perusal of fig 3 it can be seen that Kawas - Navsari line is critically loaded and there are not enough margins on other lines to meet the outage of this line. It can also be seen Kawas - Baruch 220 kV D/C line was very much under loaded. As Baruch lies on the corridor of proposed Essar - Mobha 220 kV line it was considered to meet loads of Mobha from Baruch instead of Essar pooling point. The results of this alternative is plotted in Fig 4.

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Fig 6 shows power flows on various transmission lines in the event of outage of Kawas - Navsari D/C lines. It will be observed that line flows are well within the limits.

To summarize following system is recommended for Essar and Mangrol Power Stations.

Mangrol - Essar 220 kV D/C

Mangrol - Essar 220 kV S/C

Essar - Kim 220 kV D/C

Essar - Olpad 220 kV S/C

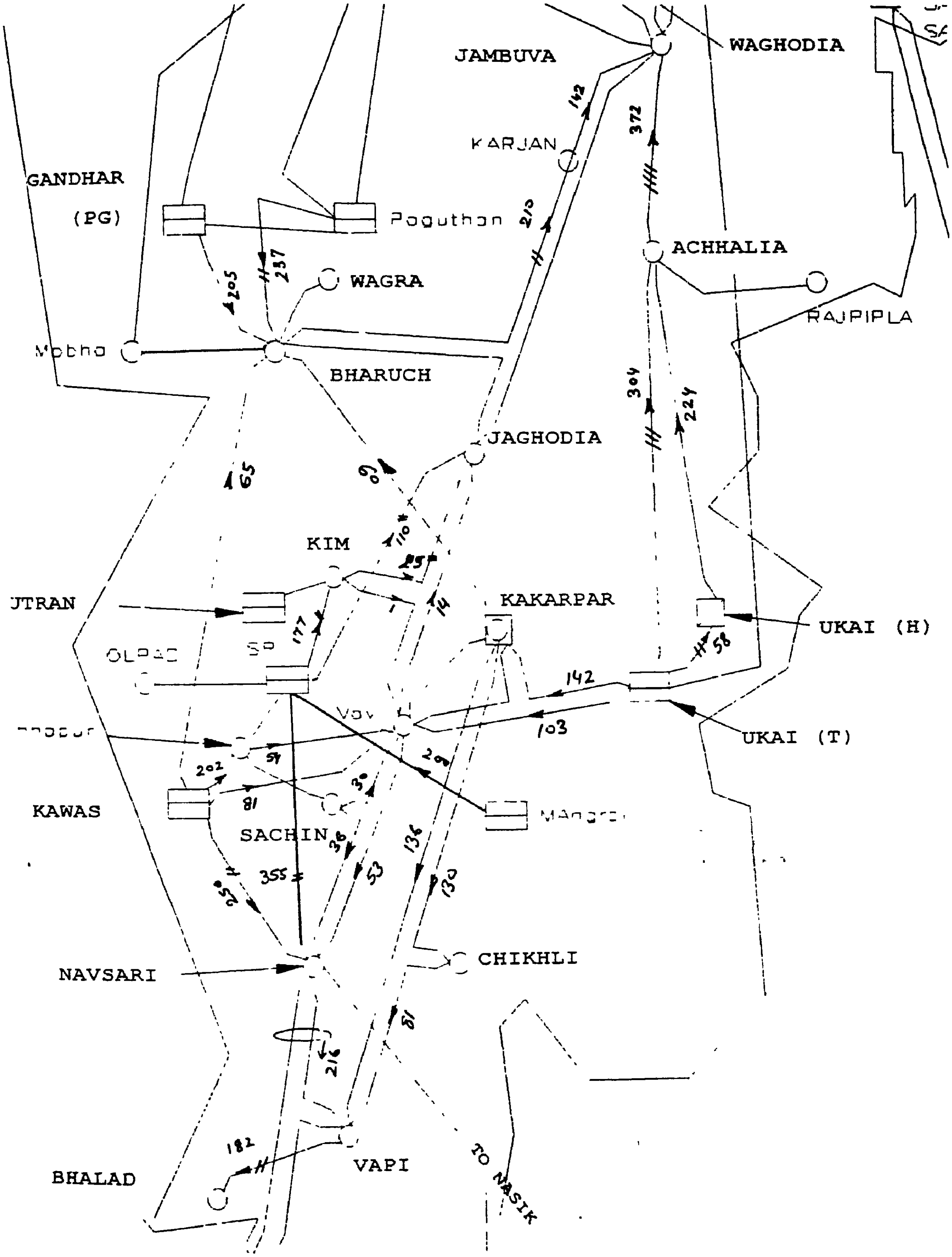
Essar - Jagodia 220 kV D/C

Essar - Mobha 220 kV D/C

Mobha - Karamsad 220 kV D/C

Essar - Navsari 400 kV D/C (to be operated at 220 kV initially).

Fig 5


JAMBUVA
WAGHODIA
142
KARJAN
372
GANDHAR
(PG)
Poguthan
210
237
205
WAGRA
ACHHALIA
RAJPIPLA
Mobha
BHARUCH
304
224
JAGHODIA
65
60
KIM
110
25
14
JTRAN
KAKARPAR
UKAI (H)
177
OLPAD
SP
58
142
Vav
103
UKAI (T)
59
202
29
KAWAS
81
30
Mangrol
SACHIN
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CHIKHLI
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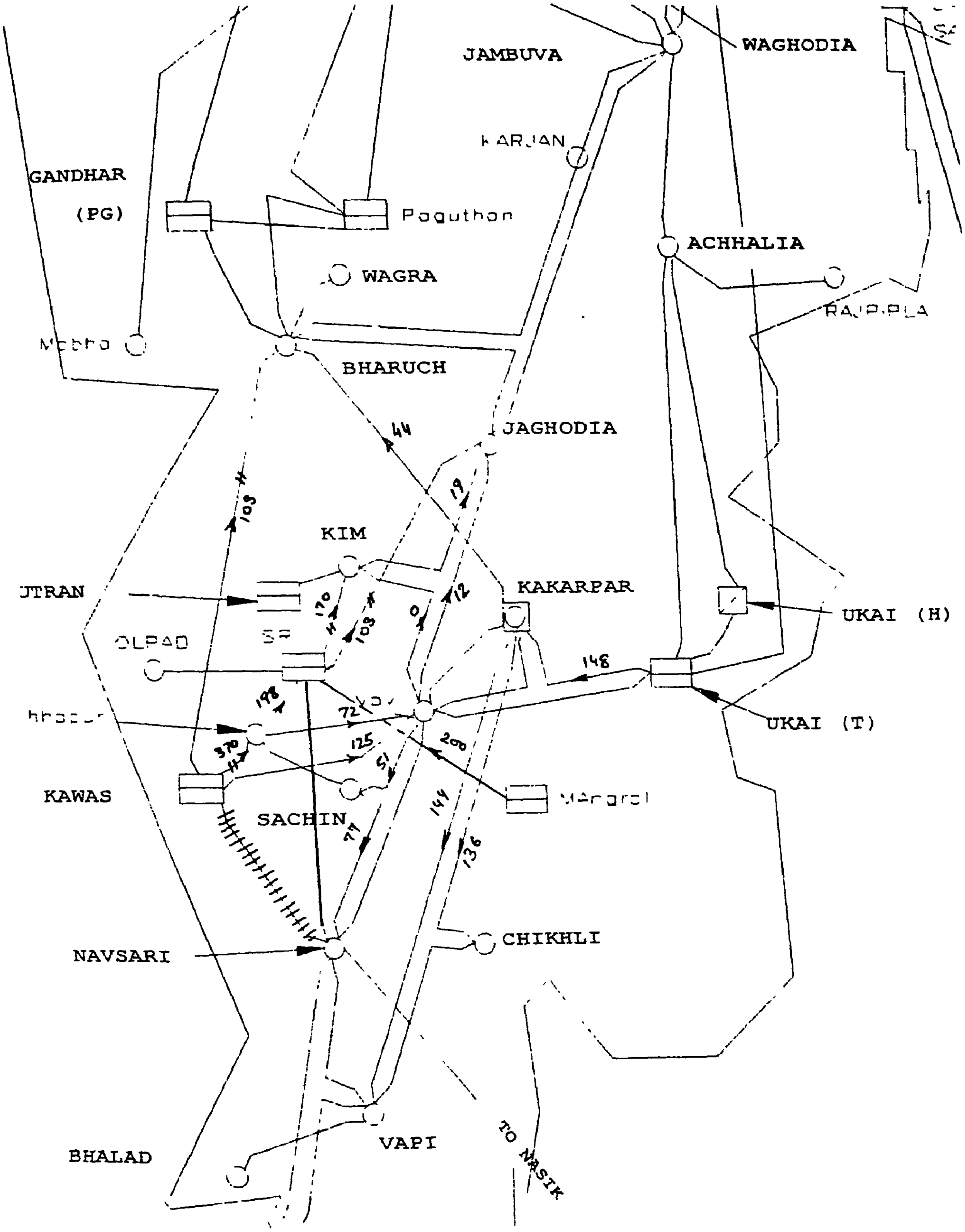
VAPI
TO NASIK

Fig 6



Power flows on various Transmission lines under outage of Kawas-Navsari Double circuit Transmission line

6.7.5 Transmission system required for evacuation of power from generating stations likely to be commissioned during IX plan in Saurashtra region

At present there is only one power station in Saurastra region i.e. Sikka with an installed capacity of 240 MW. The present day load demand of the area is around 1100 MW and most of the power is imported from rest of the state. However, during IX plan following new power stations would be added. With the commissioning of these stations, Saurastra zone would not only be self sufficient in power but would also be exporting around 200 MW to the rest of state.

Reliance (Near Jamnagar)	500 MW
Bhavnagar	300 MW
Chhara	600 MW
Pipavav	655 MW

Reliance units are located in western Saurastra, Bhavnagar units are located in North-East Saurastra and Chhara & Pipavav units are located in Southern Saurastra in close proximity. Transmission system requirements for Chhara & Pipavav power stations were determined together. Further, while determining transmission system requirement for these units it is assumed that none of the units at power stations in Saurastra would be under planned/forced outage and maximum probable generation from these power stations, as given below, have been considered

Generating Station	Installed Capacity	Despatch Considered
Reliance	500 MW	450 MW
Bhavnagar	375 MW	325 MW
Chhara	600 MW	450 MW
Pipavav	655 MW	600 MW
Sikka	240 MW	200 MW
Total	2370 MW	2025 MW

Fig 7

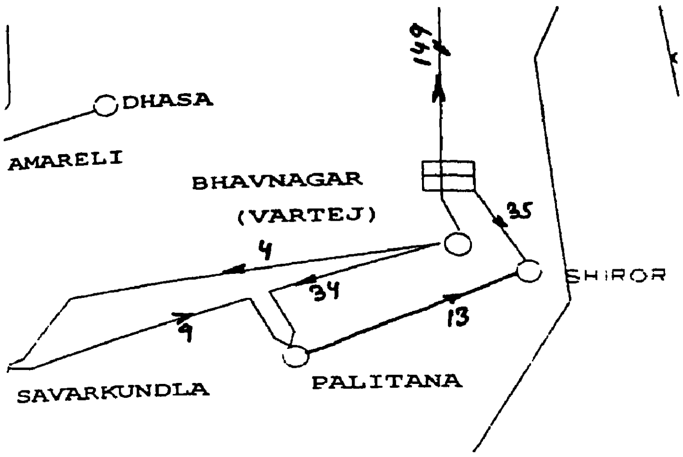


Fig 8

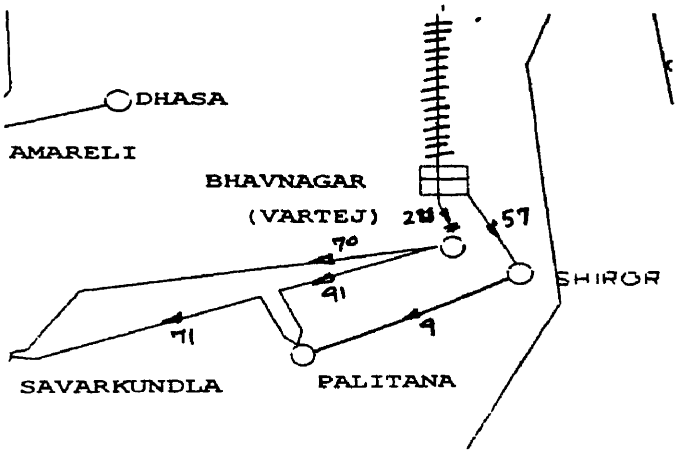


Fig 9

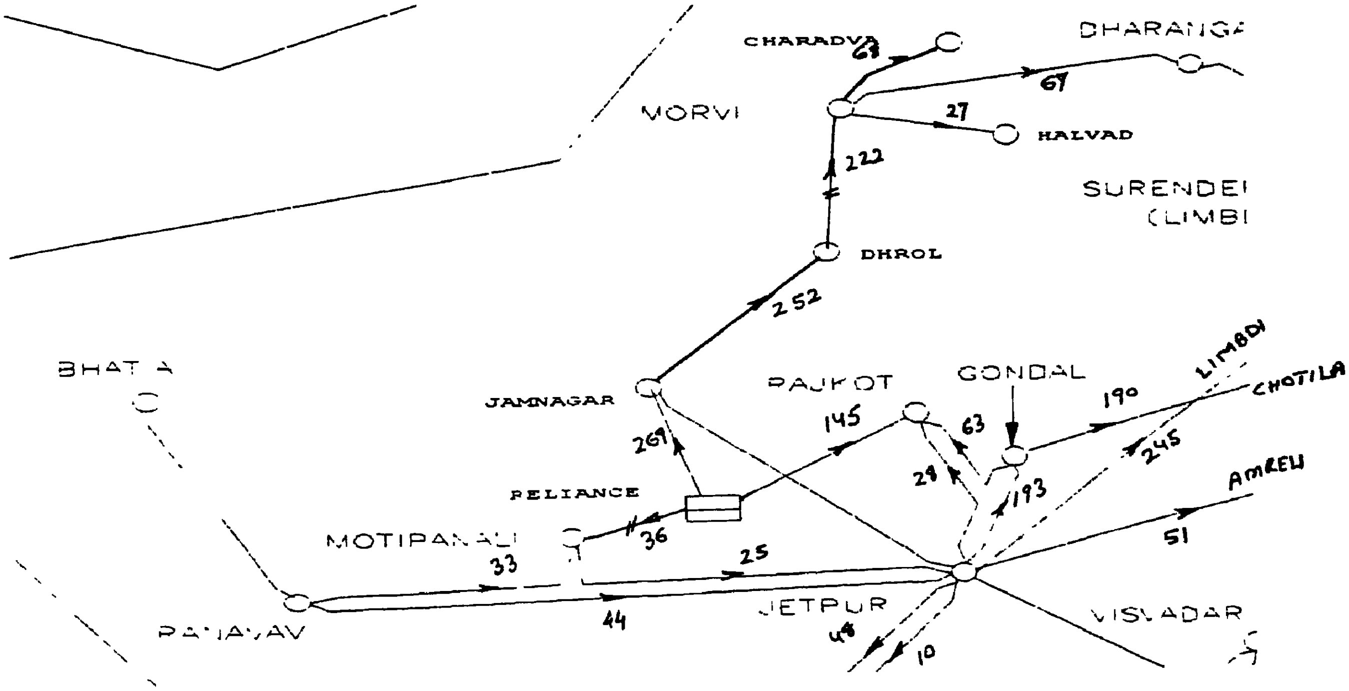
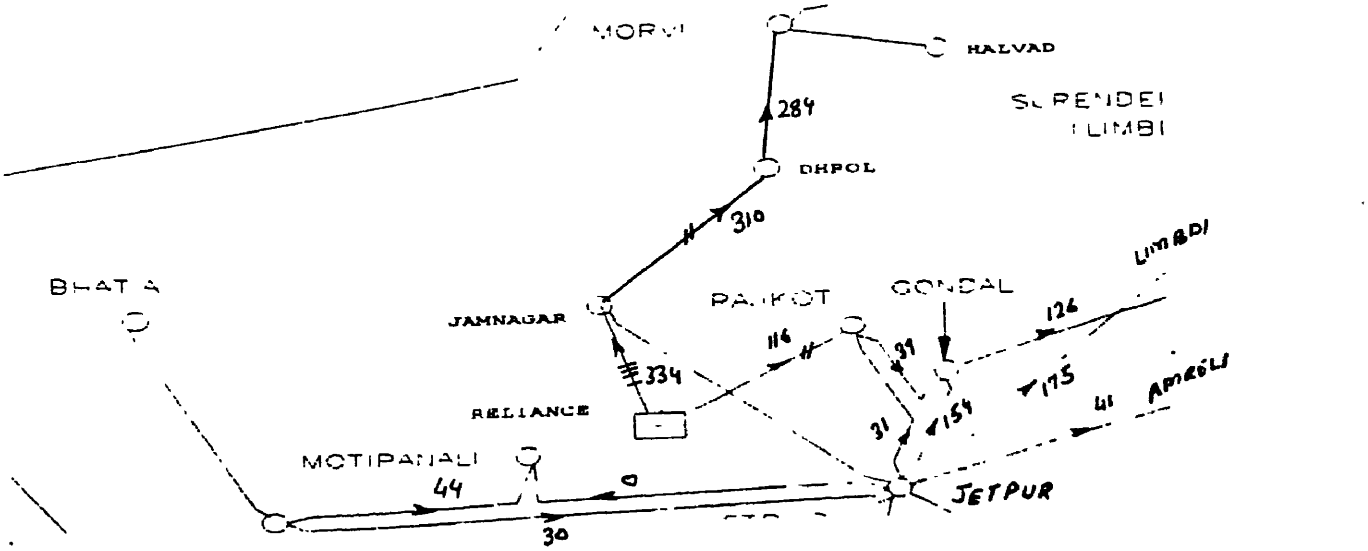


Fig 10



Total loads of Saurastra region by the end of 9th plan would be around 1800 MW. With the generation in Saurastra, as shown around 200 MW power would be surplus to be transmitted to Central/North Gujarat. Following transmission system is available to evacuate this surplus power from Saurastra.

Asoj - Limbdi 400 kV D/C
Asoj - Jetpur 400 kV S/C
Karamsad - Limbdi 220 kV D/C
Karamsad - Bhavnagar 220 kV D/C
Viramgam - Limbdi 220 kV D/C

It is therefore, quite logical to assume that only small transmission links within Saurastra would be required to evacuate power from each of new stations coming up in South Gujarat and the same are discussed in details below:

a) Bhavnagar (Ghoga) TPS - 3x125 MW.

Bhavnagar TPS is scheduled to be commissioned during last year of IX plan i.e. 2001-2002. It is proposed to step up power from this power project to 220 kV and inject it into GEB grid by LILOing both circuits of Karmasad - Vartej 220 kV D/C line and a 220 kV Bhav Nagar - Shihor D/C line. Shihor is also further connected to Palitana in Southern Saurastra. Power flows in Base Case and outage of 220 kV D/C between Bhavnagar and Karamsadis shown below in Figs 7 & 8.

b) Jamnagar (Reliance) TPS - 500 MW

Jamnagar TPS is scheduled to be commissioned after 5 years from now i.e. by 2000-2001. As per the generation program available, there is no capacity addition during next two plans. It is proposed to evacuate power from this TPS at 220 kV. To startwith following 220 kV lines were considered in the studies.

i) Reliance - Rajkot 220 kV D/C line
ii) Reliance - Motipenali 220 kV D/C line
iii) Reliance - Kalwad (Jamnagar) 220 kV D/C line
iv) Kalwad - Dhrol - Morvi 220 kV D/C line

Power flows for base case are shown in Fig. 9.

From analysis of the results, it was observed that Reliance - Motipenali 220 kV D/C line was carrying only about 34 MW. On the other hand Jamnagar line was found to be carrying most of the power and was critically loaded. Further Jetpur - Gondal and Gondal - Chotila 220 kV S/C lines were also found to be critically loaded. The Reliance - Mortipenali 220 kV D/C line was carrying only 40 MW and was thus dropped and another 220 kV D/C line (3rd & 4th ckts) between Reliance and Jamnagar was added. System studies were then repeated and results of these studies are shown in fig 10. From the results it can be seen that power flows on transmission lines were fairly balanced. The loading of Jetpur - Gondal - Chotila S/C line also got reduced.

Following transmission system associated with Reliance TPS is, therefore, recommended.

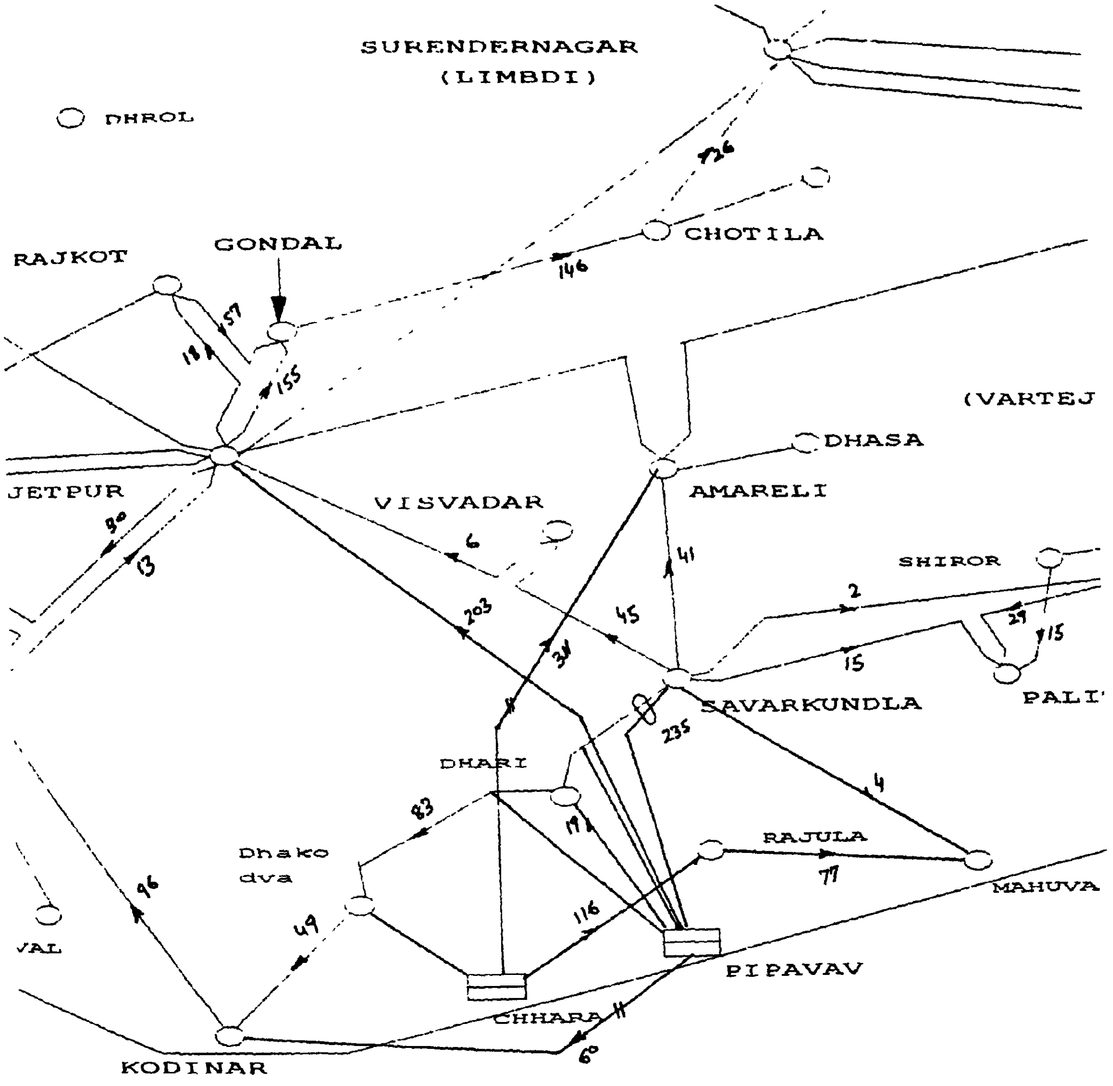
i) Reliance - Rajkot 220 kV D/C line
ii) Reliance - Kalwad (Jamnagar) 220 kV 2 x D/C lines
iii) Jamnagar - Dhrol - Morvi 220 kV D/C line

c) Chhara - 600 MW & Pipavav - 655 MW

Chhara and Pipavav projects are to be located in southern Saurastra in close proximity and near to pipavav port. It is proposed to set up a Gas based power stations at Chhara of 600 MW capacity during 9th plan with an extension of equal capacity in 10th & 11th plans. Similarly at Pipavav, it is proposed to setup Gas based power station of 655 MW during 9th plan with an addition of 1645 MW imported coal based power station in the next two five year plans. It is thus important that associated transmission system planned to evacuate power from these station available during 9th plan should also fit in to the long term perspective.

Considering the total capacity of projects, it was considered to evacuate the power at 400 kV. But due to time frame of the 1st stage of projects it may not be possible to erect 400 kV network within the given time frame and any delay in commissioning of associated transmission system would not only jeopardize the evacuation of power from these stations but also put heavy burden on GEB. In the light of above it was considered to have only 220 kV transmission system in the beginning with a scope for uprating to 400 kV during next plan.

Fig 11


SURENDERNAGAR
(LIMBDI)
DHROL
126
CHOTILA
146
RAJKOT
GONDAL
57
18
155
(VARTEJ
DHASA
AMARELI
JETPUR
80
13
VISVADAR
6
41
SHIROR
2
29
15
203
31
45
15
PALI'
SAVARKUNDLA
235
DHARI
4
83
19
Dhako
dva
RAJULA
77
MAHUVA
96
49
116
VAL
PIPAVAV
CHHARA
11
60
KODINAR

From the analysis of sub-station wise load demands given in Annex-6.3, it may be observed that total loads in southern Saurastra would be of the order of 400 MW which will be met from these power stations. Balance power of the order of 600 MW will have to be exported to Northern Saurastra pooling points for onwards transmission.

Detailed discussions on alternative studies and transmission system thus evolved is given in ensuing paragraphs.

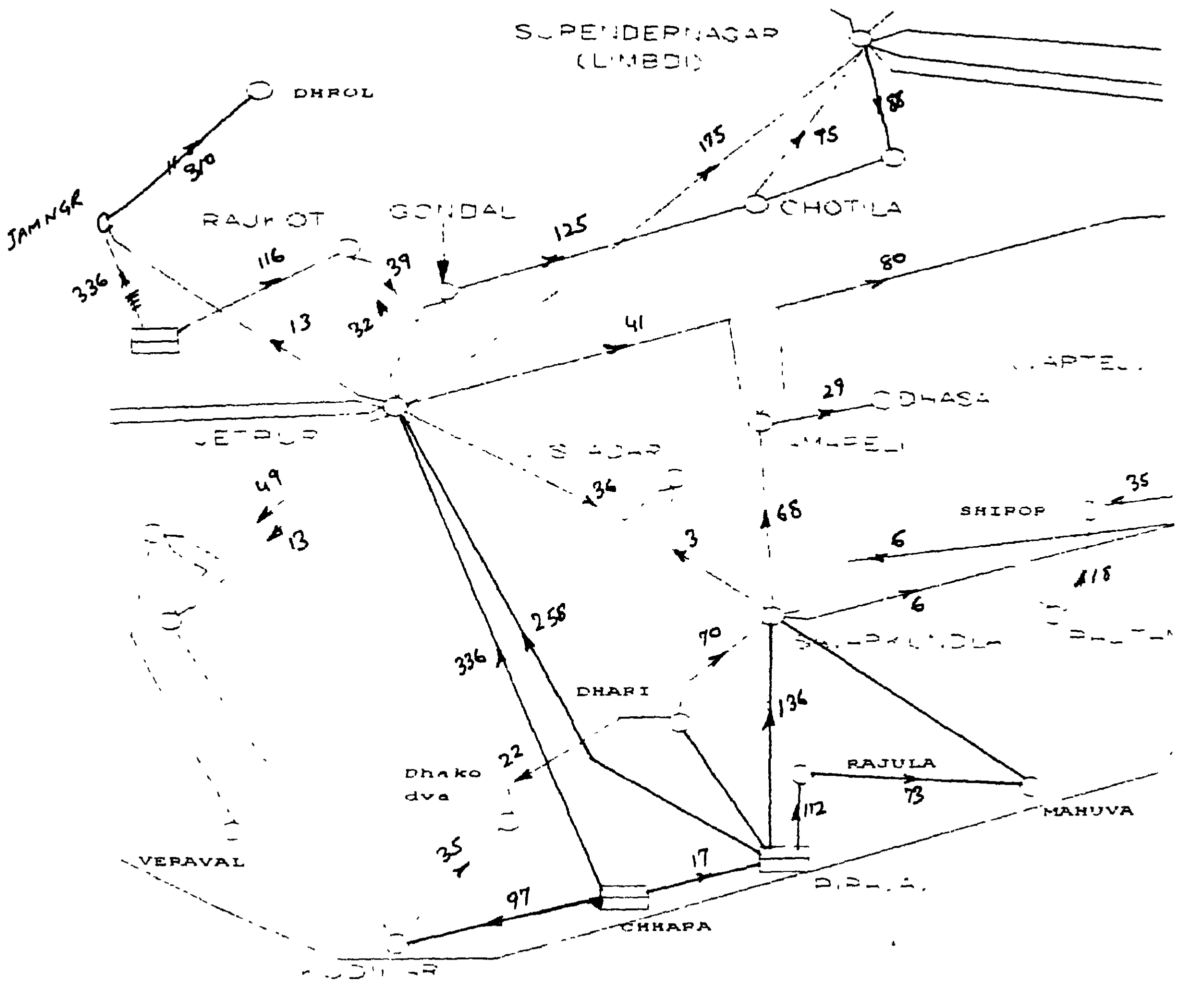
Following transmission system based on discussions with GEB and CEA was considered to start with.

Chhara - Amareli 220 kV D/C
Chhara - Dhokadve 220 kV D/C
Chhara - Rajula - Mahuva 220 kV D/C
Pipavav - Jetpur 220 kV D/C
LILO of Savarkundla - Dhakodva - Kodinar 220 kV S/C line at Pipavav
Pipavav - Savarkundla 220 kV S/C
Pipavav - Kodinar 220 kV S/C
Mahuva - Svarkundla 220 kV S/C

Results of load flow studies are plotted in fig 11. On perusal of fig 11 it can be seen that some of the lines are critically loaded and some of the lines are very much under loaded. It was also seen that power flow on Chhara - Amreli and Pipavav - Jetpur 220 kV D/C lines was 311 MW and 203 MW respectively. These lines are fully loaded and there is hardly any margin for future expansion. On the basis of analysis of the results, transmission system was readjusted and following lines were considered in the next alternative.

Pipavav - Jetpur 400 kV D/C (to be charged at 220 kV initially)
Chhara - Jetpur 400 kV D/C (to be charged at 220 kV initially)
Chhara - Pipavav 400 kV S/C (to be charged at 220 kV initially)
Pipavav - Savarkundla 220 kV D/C (to be charged at 220 kV initially)
Chhara - Kodinar 220 kV D/C
Pipavav - Rajula - Mahuva 220 kV D/C
LILO of Savarkundla - Dhakodva 220 kV S/C line at Dhari
Pipavav - Dhari 220 kV D/C
Mahuva - Svarkundla 220 kV D/C

Fig 12


SURENDERNAGAR
(LIMBDI)
DHROL
JAMNGR
310
336
RAJKOT
116
13
39
32
GONDAL
125
175
75
88
CHOTILA
80
41
29
DHASA
JETPUR
49
13
36
3
68
SHIPOP
35
6
6
118
258
336
70
DHARI
136
22
Dhako
dva
RAJULA
73
112
MAHUVA
VERAVAL
35
97
17
CHHAPA

Results are plotted in Fig 12. From the Fig 12, it can be seen that all lines are loaded well within limits. The Pipavav - Jamnagar & Chhara - Jamnagar 400 kV lines charged at 220 kV, carries about 250 and 330 MW of power respectively. Some of the lines including Pipavav - Jamnagar & Chhara - Jamnagar 400 kV lines Charged at 220 kV, which appear to be lightly loaded, would be fully loaded when additional generation of 1600 MW would be commissioned during X plan. So the above system is recommended.

6.7.6 Summary

Following Transmission lines would be required for evacuation of power from Generating station likely to commissioned during 1996-2002 (last year of VIII plan and IX plan)

Line Section	No. of Ckts.	Length (kM)	
400 kV Lines (to be operated at 220 initially)			
Chhara - Jetpur	D/C	150	
Chhara - Pipavav	D/C	40	
Pipavav - Jetpur	D/C	160	
Pipavav - Svarkundla	D/C	64	
Sardar Sarovar - Asoj	D/C	40	Under Const.
Paghuthan - Karamsad	S/C	119	Under Const.
Kosamba (Essar) PP - Navsari	D/C	45	
220 Lines			
Gandhi Nagar - Kalol (Jamla)	2 x D/C	16	
Kalol - Nardi pur	D/C	16	
LILO of Karamsad - Chironia (Limbdi) S/C line at Salejada			
LILO of Chhetral - Viramgaum S/C line at Ranchhodpur			
Panandaro - Bharanda	D/C	20	
LILO of Mehsana - Anjar Ckt no.1 at Rapar and Radhanpura		30	
Wanakhon - Kapadvanj	D/C	54	Under Const.
Kapadvanj - Ranasan	D/C	52	Under Const.
Dehgaum - Ranasan	D/C	40	Under Const.
LILO of Wanakbori - Ranasan S/C line at Kapadvanj		10	Under Const.
LILO of Baruch - Karamsad D/C line at Paghuthan		15	Under Const.
Essar - Icchapur	D/C	16	Under Const.
Icchapur - Sachin	D/C	25	Under Const.
LILO of one of the ckt of Vav - Navsari D/C line at Sachin		10	Under Const.
Mangrol - Kosamba (Essar) PP	T/C	46	

Line Section	No. of Ckts.	Length (kM)
Kosamba - Kim	D/C	24
Kosamba - Jagodia	D/C	48
Kosamba - Olpad	D/C	50
Baruch - Mobha	D/C	86
Mobha - Karamsad	D/C	74
Ghoga (Bhavnagar) - Shiror	S/C	70
LILO of Bhavnagar - Karamsad D/C line at Ghoga		15
Reliance - Rajkot	D/C	70
Reliance - Jamnagar	2 x D/C	30
Jamnagar - Dherol - Morvi	D/C	100
Pipavav - Rajula - Mahuva	D/C	72
Pipavav - Dhari	D/C	45
Mahuva - Svarkundla	S/C	52
Chhara - Kodinar	D/C	15
LILO of Svarkundla - Dhakodva S/C at Dhari		15

6.7.7 Additional Transmission System required for system strengthening

In addition to transmission system required to evacuate power from various power stations following lines would also be required to meet growing local load demand and to strengthen the existing system and some of these lines are already approved as VIII plan works and are under construction.

Line Section	No. of Ckts.	Length (kM)
220 kV Lines		
Zerda - Jantra	D/C	40
Zerda - Deesa	D/C	40
Himmat Nagar - Khedbrahma	D/C	50
Achhalia - Rajpipla	S/C	40
Kapadvanj - Sevalia	S/C	40
Chronania - Sanand	S/C	75
Viramgam - Ranchhodpura	S/C	35
Morbi - Chardva	S/C	30
Morbi - Halvad	S/C	50
Shapur - Veraval	S/C	50
Limbdi - Jasdan	S/C	40

Line Section	No. of Ckts.	Length (kM)
LILO of Jambua - Baruch ar Karjan		10
LILO of Asoj - Karamsad at Kanbha		10

It is recommended that with a view to preserve right of way and considering the future load prospects the economics of constructing all 220 kV S/C lines in the area on D/C towers may be worked out to arrive at a final decision.

220 kV Substations

Name of Substation	Capacity (MVA)
Rajpipla	100
Karjan	100
Savli	100
Sevaliya	100
Sanand	100
Kanbha	100
Jotna	200
Ranchodpura	100
Jantral	100
Rajula	100
Dhari	100
Charadva	200
Halval	100
Verabal	100
Khedbrahma	200
Radhanpura	100
Deesa	200
Shihor	100
Dhrol	100
Jasdan	200
Rapar	100
Baranda	100
Olpad	200

Complete Gujarat power grid with transmission system proposed for IX plan along with power flows is shown in EXHIBIT 6.2

6.7.3 *Reactive Compensation*

In order to keep system voltage profile with in permissible limits as defined in CEA's Manual on Transmission Planning Criteria - June 1994 (Refer Appendix-A) adequate shunt compensation has been provided. Sub-station wise details of reactive compensation is given in Annex 6-5. From this annexure, it can be seen that shunt capacitors of the order of 3290 MVAR will have to be provided in GEB Grid at 132 kV and above which exclude shunt requirement at lower voltage to bring power Factor at 132 kV (and above) buses equal to 0.95. Out of these, 1750 MVAr are existing and 1540 MVAr are required to be provided during 1996-2002 period.

6.8 Transmission system requirement during Eleventh Plan (2007-2012)

6.8.1 *Generation despatch schedules*

It is proposed to setup Solar (400 MW), Wind (200 MW) & Tidal (900 MW) power stations in the state during X plan & XI plan periods. Power availability from these power stations is solely dependent upon mother nature. Accordingly these stations have not been considered for meeting the peak demand while preparing generating schedules. Adequate measures, however, have been taken to evacuate power from these stations. It also proposed to import power, other than state's share in Central Sector generating stations in Western Region, from power stations located in other state/regions. These are

Parbati (HP)	500 MW
Cepa (Orissa)	1980 MW
Sipat (MP)	1500 MW

In order to fix suitable injection points for these power stations, zone-wise load generation balance was also drawn. According to this Kutch, Saurastra and South Gujarat would be surplus in power, but there would be acute shortage of power in North and Central Gujarat. It would, therefore, be prudent to inject power from these power station into Central and North Gujarat.

It may also be noted that Gujarat's total share in Central Sector power stations in Western Region would be almost equal to total power generation from Central Sector generating stations located in Gujarat and there would only be nominal power flow on existing 400 kV Indore- Asoj D/C lines. In order to utilise this corridor, it proposed to import power

Fig 13

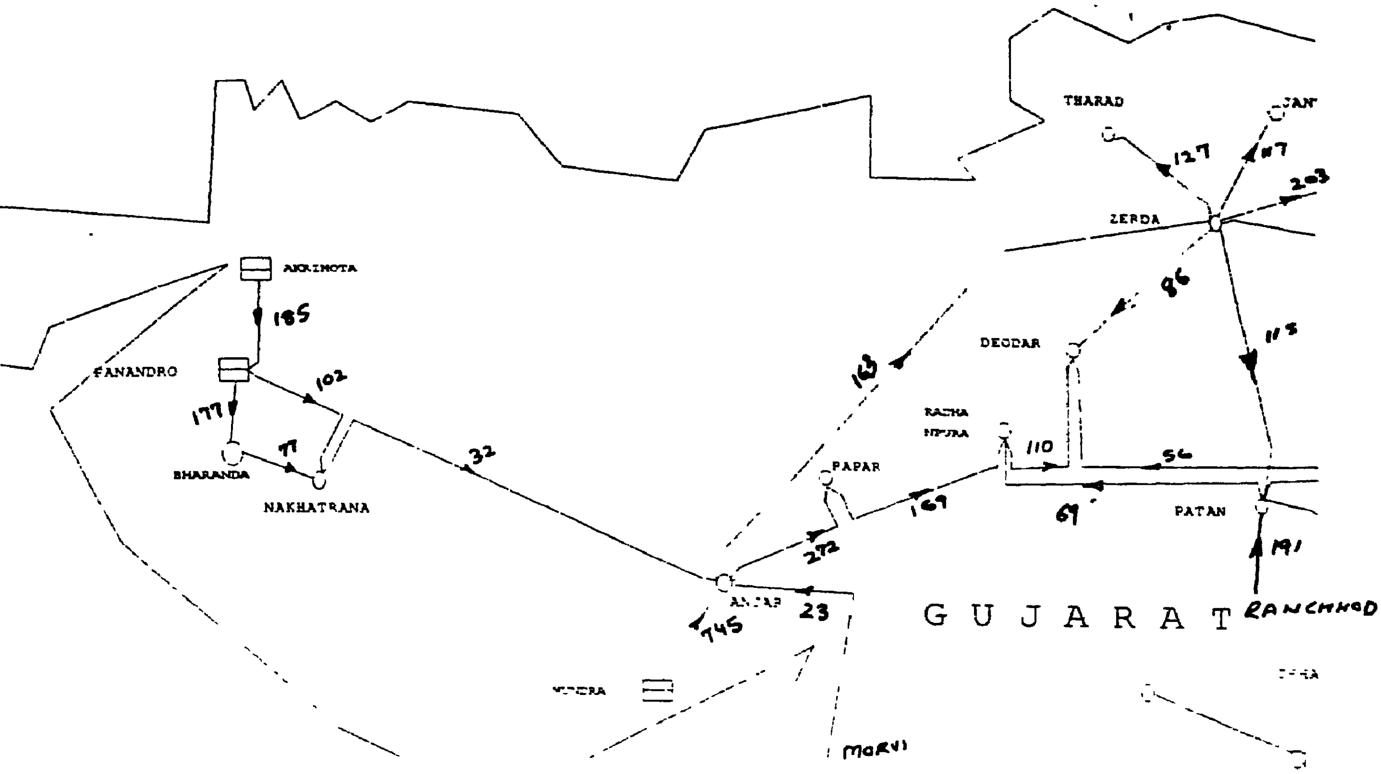
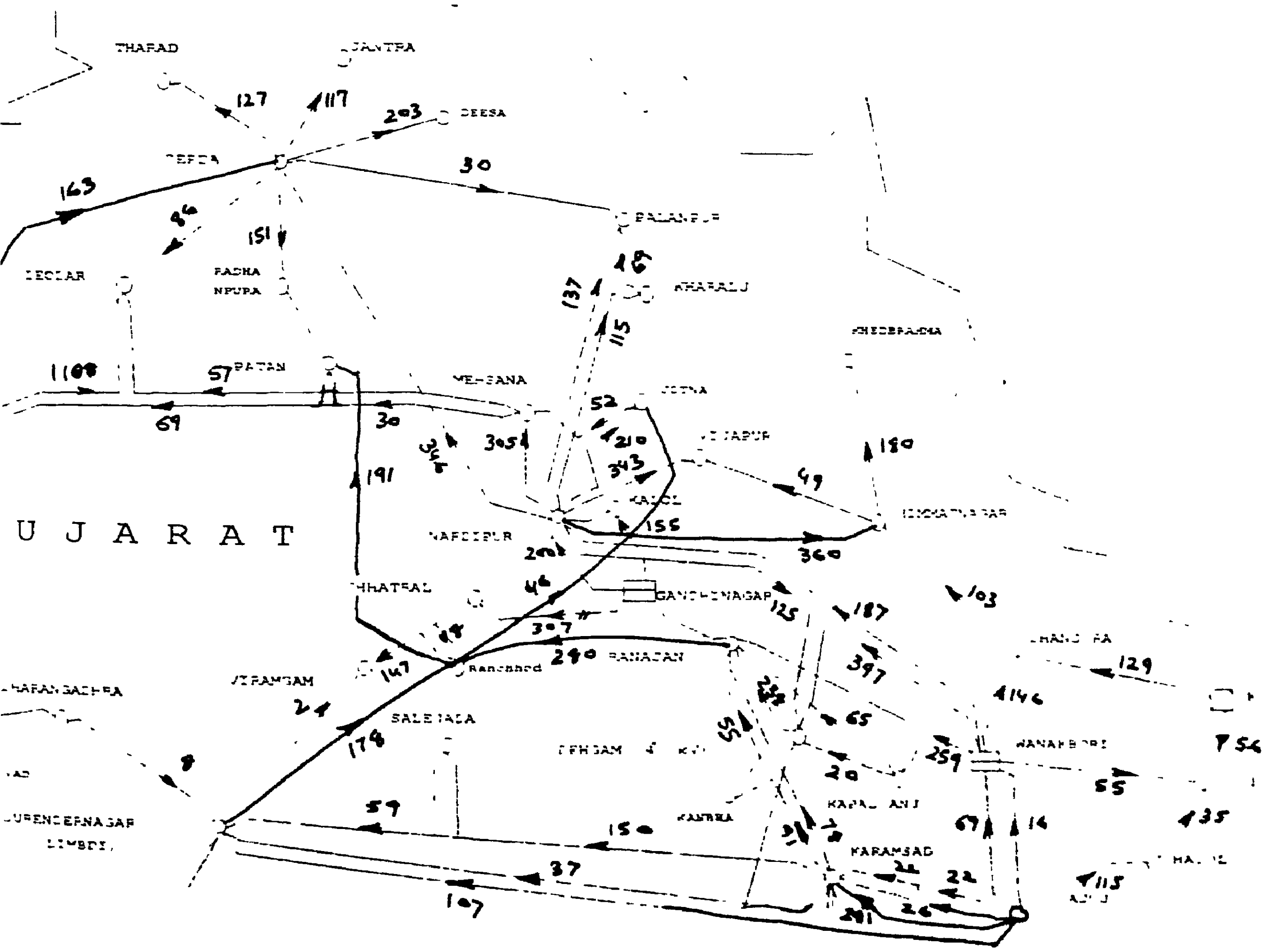

THARAD
JAN
127
117
203
ZERDA
86
115
DEODAR
RADHA
NPURA
110
56
69
PATAN
191
RANCHHOD
GUJARAT
AKRIMOTA
185
FANANDRO
102
177
77
BHARANDA
NAKHATRANA
32
163
PAPAR
169
272
ANJAR
23
745
MUNDRA
MORVI

Fig 14


THARAD
JANTRA
127
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DEESA
ZERDA
30
PALANPUR
163
86
151
DEODAR
RADHA
NPURA
137
18
KHERALU
115
KHEDBRAHMA
1108
57
PATAN
MEHSANA
69
30
305
52
210
343
VIJAPUR
180
49
HIMATNAGAR
191
KALOL
155
360
GUJARAT
GANDHINAGAR
46
125
187
103
307
240
147
Ranchhod
VIRAMGAM
24
179
397
65
129
54
259
VANAKBORI
55
8
20
KAPADVANJ
59
150
37
107
KARAMSAD
22
22
67
14
435
115
HALOL
201
26
SURENDERNAGAR
LIMBDI

from Sipat STPS (MP) over the existing 400 kV lines at Asoj. It may also be appreciated that power from Sipat, being located in MP, will be first utilised by MP and Gujarat's share will be adjusted against MP's share in Sardar Sarovar HEP, which is located in Gujarat. With Sipat power injected at Indore, Power short-fall in Central Gujarat gets reduced to only about 100 MW. To have minimum transmission system requirement, it would, therefore, be necessary to inject power from Cepa and Parbati into North Guajrat only. Zone-wise load generation balance alongwith inter zonal power flow is shown at Annex - 6.2-3. From this Annex, it can be seen that inter-zonal power flows are restricted to about 800 MW only.

6.8.2 Transmission system required for power evacuation from generating stations likely to be commissioned during the period 2002-2012 in Kutch region

Following power stations are likely to be commissioned in Kutch region during X & XI plan periods.

Akrimota	250 MW
Mundra	1000 MW
Solar	200 MW
Wind	400 MW
Tidal	900 MW

Akrimota TPS would be located north of existing Panadoro TPS. The following transmission system is proposed to evacuate power from this power station.

Akrimota- Panandaro 220 kV D/C

Akrimota - Panandaro 220 kV S/C

LILO of 2nd circuit of Panandaro - Anjar 220 kV D/C line at Nakhatrana

Total peak load demand of east Kutch pocket, would be around 300 MW against power availability of 345 MW from these two power stations. Thus only 45 MW of power would be surplus to flow towards Anjar for which 220 kV existing D/C line is adequate.

Mundra TPS would be located at south of Anjar. It is proposed to evacuate power from this TPs at 400 kV over three 400 kV circuits to Anjar and establish a 400 kV pooling station at Anjar. From Zonal load generation balance, it can be seen that about 300 MW would be surplus in Kutch region. In addition, Solar, Wind and Tidal would constitute a number of small power stations. It is proposed to pool power from these power stations at

some suitable location i.e Bhuj or Anjar and export surplus power from Kutch region to other zones. It is proposed to connect Anjar pooling station with Zerda (North Gujarat) on one side and with Morvi (Saurastra) on other side by 400 kV D/C lines. These lines alongwith existing 220 kV line between Anjar and Mehsana (to be LILO at Rapar, Patan etc) would be adequate to evacuate surplus power from Kutch region. Power flows are shown in Fig 13.

6.8.3 *Transmission system required for power evacuation from generating stations likely to be commissioned during the period 2002-2012 in North Gujarat*

No new generating station, except some small thermal stations, are likely to be commissioned in North Gujarat. However, as discussed above power from Parbati HEP in HP and CEPA TPS in Orissa is proposed to be injected at Zerda and Nardipur through dedicated point to point HVDC lines.

Even with this power North zone would be facing deficit by about 1200 MW. Out of this about 400 MW would come from Kutch region and balance would have to made available from South Gujarat and Saurastra via Central Gujarat. For this purpose following additional system would be required.

Ranasan - Ranchhodpura 400 kV D/C line

Limbdi - Ranchhodpura 400 kV S/C line

Ranachhodpura - Patan - Zerda 400 kV S/C line

Nardipur - Himmat Nagar 400 kV S/C

The above system alongwith existing transmission links between Central gujarat and North Gujarat are adequate to meet the requirement. Power flows are shown in Fig 14. From the fig it can be seen that loading of all transmission lines remain well within limit and outage of any link can be met with.

6.8.4 *Transmission system required for power evacuation from generating stations likely to be commissioned during the period 2002-2012 in Central Gujarat*

Only Dhuvaran (replacement) TPS in addition to some small thermal stations, wind and solar stations are likely to be added in Central Gujarat. On the other hand, one unit of 210 MW at Wanakbori is also to be retired during the period. It is proposed to step up power from Dhuvaran TPS to 132 kV and evacuate through existing transmission system. In addition it

is proposed to inject power from SIPAT TPS in MP at Asoj through displacement. Thus total power (Sipat+Sardar Sarovar) available at Asoj would be around 1100 MW. Four outlets at 400 kV and eight outlets at 220kV are available at Asoj to distribute this power to various load centers in Central and North Gujarat and no new transmission system would be required. Power flows are shown in Fig 14 on previous pages. From the fig it can be seen that power flows are well within limits and outage of any line can be met with.

6.8.5 Transmission system required for power evacuation from generating stations likely to be commissioned during the period 2002-2012 in South Gujarat

Following generating stations are likely to be commissioned by the end of 2011-2012 in South Gujarat.

Gandhar (Ext)	655 MW
Mangrol (Ext)	500 MW
Surat	500 MW
Gujarat West Coast	500 MW
Kawas (Ext)	650 MW
TAPP (Ext)	500 MW (Gujarat's share)

Where as Gandhar (Ext) would be located at upper reaches of South Gujarat, remaining stations are located in close proximity to Southern portion of South Gujarat. It is, therefore, thought prudent to evolve transmission requirement for these stations together. From Zonal load generation balance, it can be seen South Gujarat would be surplus by about 800 MW of power. This surplus power is to be transmitted to load centers located in Central/North Gujarat. Existing/planned transmission system is adequate to handle this much power and only small transmission links would be required to evacuate power from new generating stations and to take it existing load centers/pooling points in South Gujarat for further transmission to Central Gujarat. Transmission system for each of the new generating stations coming up in South Gujarat is discussed in detail as below.

a) Gandhar (Ext) 655 MW

At Gandhar a 655 MW CCGT of NTPC is already existing and another CCGT of GEB of equal capacity is likely to be commissioned in 1997-98. It is proposed to have additional 655 MW CCGT as extension to GEB's CCGT at Gandhar during IX plan.

Following transmission lines are available to evacuate power from Gandhar (NTPC) and Gandhar (GEB)

Gandhar (NTPC) - Dehgaum 400 kV D/C
Gandhar (GEB) - Karamsad 400 kV S/C
Gandhar (NTPC) - Padhga 400 kV S/C
Gandhar (NTPC) - Gandhar (GEB) 400 kV S/C
Gandhar (NTPC) - Baruch 220 kV D/C
Gandhar (GEB) - Baruch 220 kV D/C
Gandhar (GEB) - Karamsad 220 kV D/C

It may be pointed out that Gandhar (Ext) was earlier planned under central sector and transmission system associated with Gandhar (NTPC) was planned to evacuate power from both the stages of 655 MW each. However, Gandhar (Ext) under central sector was dropped and it is now proposed to have it under state sector. As both power stations lie very close to each other and are connected at 400 kV level, transmission system already evolved, thus appeared to be adequate. Studies, however, revealed that 220 kV lines towards Baruch carries more than 200 MW/ckt thus gets overloaded and require strengthening. A 220 kV line between Baruch and Mobha planned to evacuate power from Mangrol TPS in IX plan period was LILOed at Gandhar and another small 220 kV D/C link between Gandhar and Wagra was added. With these additions the flows on 220 kV lines between Gandhar and Baruch remained with in limits. Power flows with the proposed system is shown in Fig 14.

b) Surat (500 MW), Mangrol Ext (500 MW), Gujarat West Coast (500 MW) and TAPP Ext (500 MW - Gujarat's Share), Kawas Ext (655 MW)

All these power stations lie very close to each other and it is thought prudent to determine transmission system requirement for these power stations together. It may be pointed out that transmission system evolved for evacuation of power from Essar (515 MW) and Mangrol (250 MW) during 9th plan period, a pooling point near Essar (Kosamba) is recommended. To start with, power from these stations was proposed to be evacuated at 400 kV through following lines.

Surat - Kosamba (Pooling Point)	400 kV D/C
Gujarat (West Coast) - Kosambha	400 kV D/C
Mangrol - Navasari	400 kV D/C
TAPP Ext - Bhilad	400 kV D/C
Bhilad - Navasari - Kosamba PP	400 kV D/C
Kawas Ext. - Kosamba PP	400 kV D/C

In addition to above 400 / 200 kV Inter Connecting Transformers at following locations were considered in the system studies.

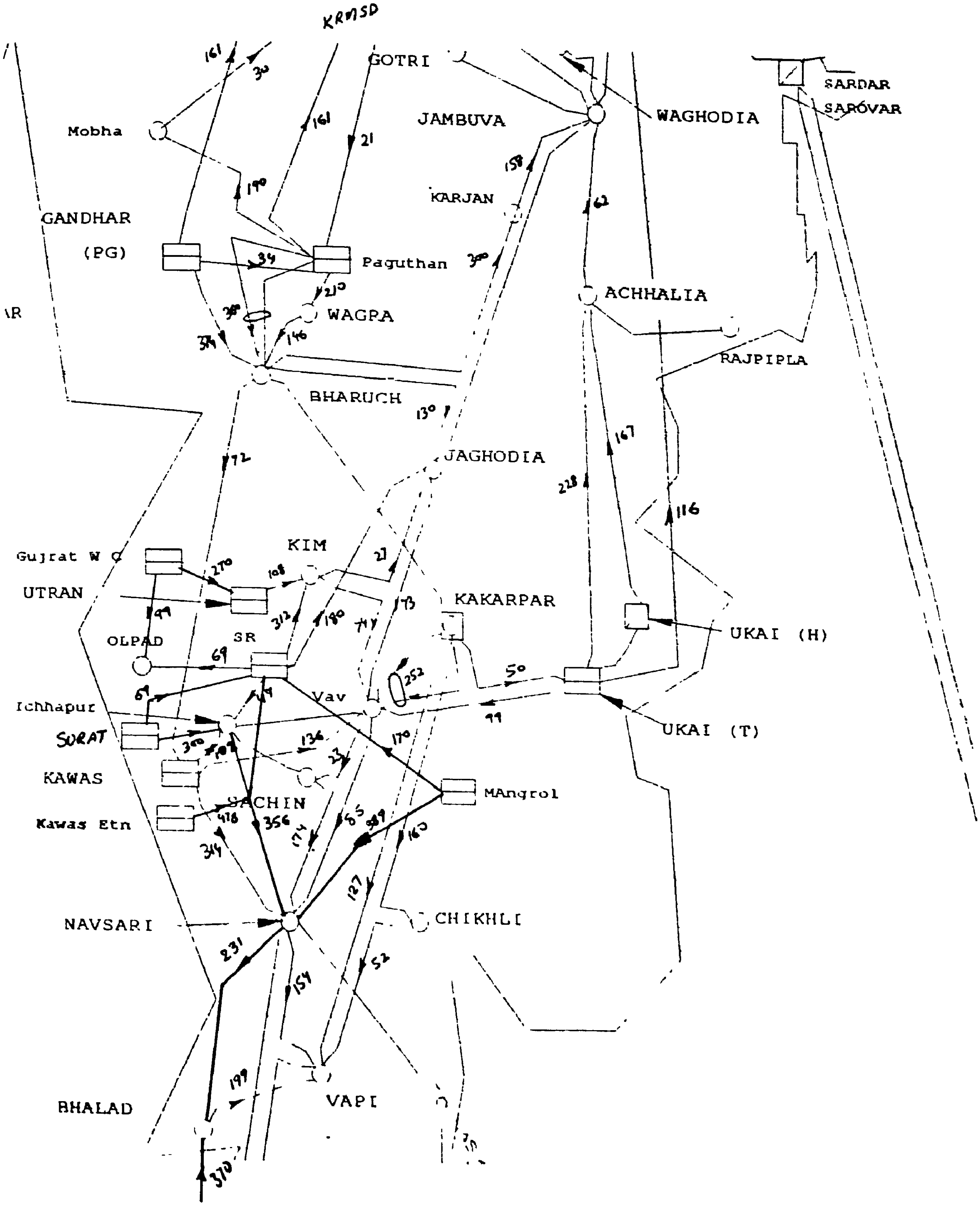
Navasari	630 MVA
Bhilad	630 MVA
Kawas	315 MVA
Mangrol	315 MVA
Kosamba P.P.	315 MVA

System studies were carried out with the above proposals and it was found that some of the 220 kV lines emanating from Kosamba P.P. were getting overloaded. The Kosambha - Kim 220 kV D/C line was loaded up to 450 MW and Kosamba - Hazira section was found to be carrying about 425 MW. To avoid this overloading the proposed 400 kV levels at Surat and Gujarat West Coast were abonded and following changes in the proposed system were carried out.

Gujarat West Coast - Kosmba PP 400 kV D/C	deleted
Surat - Kosamba PP 400 kV D/C	deleted
Gujarat West Coast - Utraan 220 kV D/C	added
Gujarat West Coast - Olpad 220 kV D/C	added
Surat - Ichhapur 220 kV D/C	added
Surat - Kosamba 220 kV D/C	added

Studies were then repeated with modified system and it was observed that power flows on all lines remained within limits. Power flows with the above modified system are shown in Fig 15.

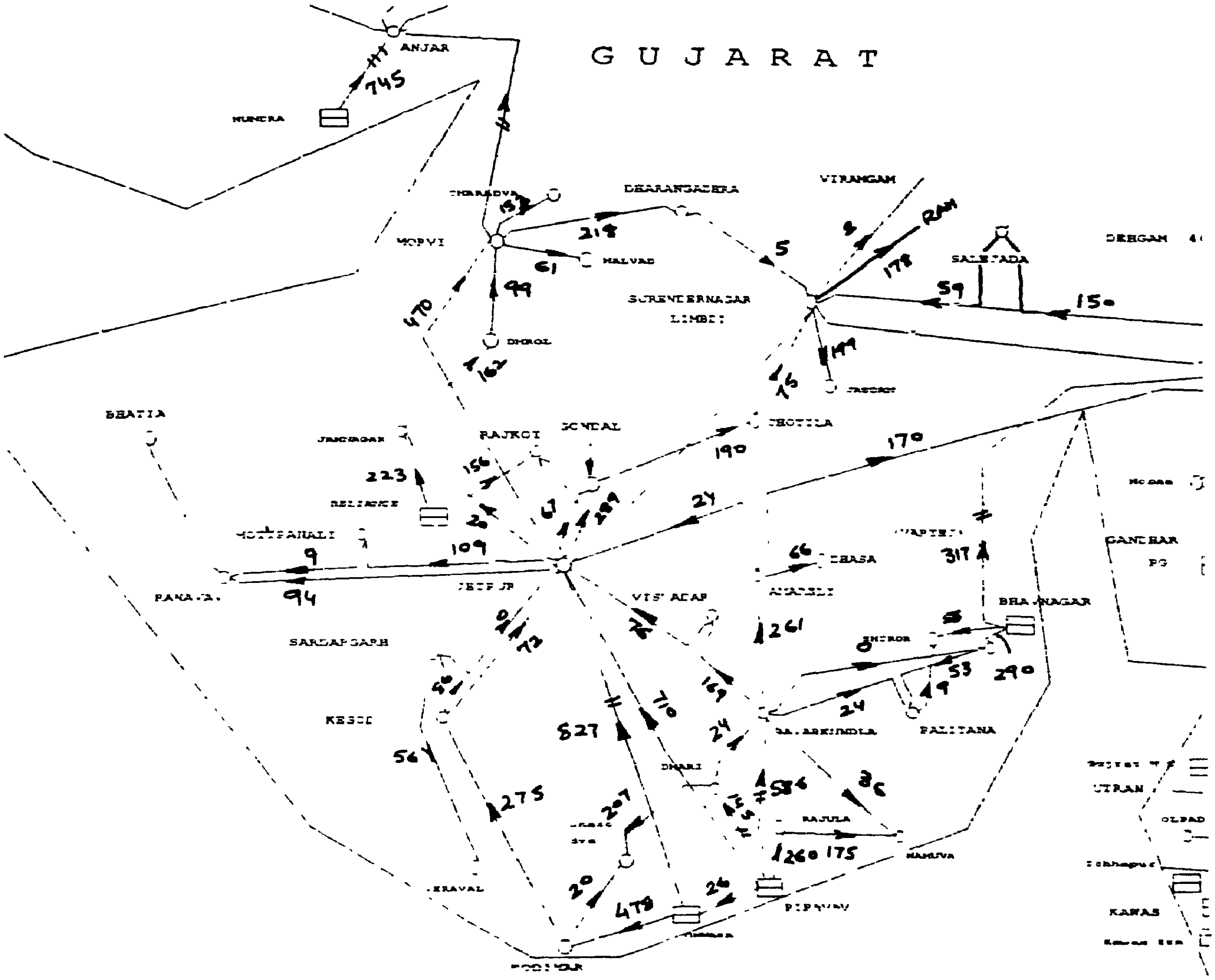
Fig. 15


KRMSD
161
30
GOTRI
JAMBUVA
WAGHODIA
SARDAR
SAROVAR
Mobha
161
21
190
158
KARJAN
62
GANDHAR
(PG)
34
Paguthan
30
210
ACHHALIA
\R
30
WAGRA
34
146
RAJPIPLA
BHARUCH
130
JAGHODIA
167
72
228
116
Gujrat W C
KIM
270
108
27
UTRAN
KAKARPAR
99
312
190
173
44
OLPAD
SR
UKAI (H)
69
252
50
Ichhapur
69
Vav
99
UKAI (T)
SURAT
300
136
170
KAWAS
108
23
MAngrol
SACHIN
Kawas Etn
418
356
65
389
34
174
160
127
NAVSARI
CHIKHLI
231
52
154
199
BHALAD
VAPI
370
70

6.8.6 *Transmission System required for Power evacuation from Generating Stations likely to be commissioned during the period 2002-2012 in Saurastra*

As described earlier in para 6.7.5 (c), program for capacity additions during X plan and XI plan indicate that 1200 MW and 1655 MW would be added at Chhara and Pipavav respectively. Accordingly transmission system planned for evacuation of power from stage - I of these power station, interalia, included Chhara - Jetpur, Pipavav - Jetpur & Pipavav - Savar Kundla 400 kV D/C lines to be operated at 220 kV initially. With the additional generation at Chhara and Pipavav, it is proposed to operate these lines at 400 kV. In addition a 400 kV line between Jetpur and Morvi and additional 220 kV D/C line (3rd & 4th ckts) between Chhara and Kodinar were also considered. To evacuate additional power from Bhavnagar TPS, a 220 kV D/C (3rd & 4th ckt) between Bhavnagar and Vartej were added. System studies were carried out with above system. Results of the studies are plotted in Fig. 16. From the fig it can be seen that all lines are loaded well with in limits and have sufficient margins to meet outage of any element.

Fig. 16


GUJARAT
ANJAR
745
MUNDRA
CHARADVA
15
MORVI
219
61
HALVAD
99
470
DHROL
162
DHRANGADHRA
VIRAMGAM
5
8
RAM
178
SALEJADA
DEHGAM
59
150
SURENDERNAGAR
LIMBDI
149
16
JASDAN
CHOTILA
190
170
BHATIA
JAMNAGAR
RAJKOT
GONDAL
223
156
RELIANCE
24
67
289
24
MOTIPANALI
109
9
94
RANAVAV
JETPUR
0
72
SARDARGARH
KESOD
40
56
275
VERAVAL
VISAVADAR
26
AMRELI
66
DHASA
261
VARTEJ
317
BHAVNAGAR
5
SIHOR
0
53
290
49
24
169
710
527
SAVARKUNDLA
PALITANA
24
DHARI
534
36
45
RAJULA
1260
175
MAHUVA
207
20
478
26
PIPAVAV
GANDHAR
PG
UTRAN
OLPAD
Ichhapur
KAWAS

6.8.7 Summary

Following transmission lines would be required for evacuation of power from generating station likely to commissioned during 2002-2012 (X & XI plan periods)

Line section	No of Ckts	Length (kM)
400 kV lines		
Anjar - Zerda	D/C	170
Anjar - Morvi	D/C	30
Nardipur - Himmat Nagar	D/C	70
Ranasan - Ranchhodpura	D/C	60
Ranchhodpura - Limbdi	S/C	70
Ranchhodpura - Patan	S/C	70
Zerda - Patan	S/C	65
Mangrol - Navasari	D/C	70
TAPP Ext - Bhilad	D/C	50
Bhilad - Navasari	D/C	80
Kawas Ext - Kosamba PP	D/C	35
Jetpur - Morvi	D/C	130
400 kV operation of following lines which were planned for 220 kV operation during IX plan		
Kosamba - Navasari	D/C	45
Pipavav - Jetpur	D/C	160
Pipavav - Svarkundla	D/C	64
Pipavav - Chhara	D/C	40
Chhara - Jetpur	D/C	150
220 kV lines		
Aknmota - Panandaro	D/C	45
Bharanda - Nakhtrana	D/C	35
LILO of 2nd ckt of Panandaro- Anjar line at Panadaro		15
LILO of 2nd ckt of Anjar - Mehsana line at Radhanpura and Rapar (1st Ckt LILOed in 9th plan)		30
Gujarat West Coast - Utran	D/C	15
Gujarat West Coast - Olpad	D/C	15
Surat - Ichhapur	D/C	8
Surat - Kosamba PP	D/C	33
Gandhar (GEB) - Wagra	D/C	22
LILO of Baruch - Mobha D/C line at Gandhar (GEB)		10

Line section	No of Ckts	Length (kM)
Stringing of 2nd ckt of following 220 kV lines		
Achhalia - Rajpipla	S/C	40
Kapadvanj - Sevalia	S/C	40
Chronania - Sanand	S/C	75
Viramgam - Ranchhodpura	S/C	35
Morbi - Chardva	S/C	30
Morbi - Halvad	S/C	50
Shapur - Veraval	S/C	50
Limbdi - Jasdan	S/C	40
400 /220 kV Substations/ICT's		
Location	**Capacity (MVA)**	
Anjar	630	
Zerda	630 (additional)	
Patan	630	
Ranchhodpura	630	
Himmat Nagar	630	
Nardipur	315 (additional)	
Morvi	600	
Pipavav	630	
Svarkundla	630	
Mangrol	315	
Bhilad	1000	
Navasari	1000	

6.9 Transmission System Requirement During Tenth Plan (2002-2007)

As already explained in para 6.2, the methodology adopted to prepare prospective transmission system for the state of Gujarat for the period 1996-2002 is to develop the system for ultimate time frame i.e. for 2011-2012 conditions taking in to consideration the loads and generation likely to be available by that time. Once the system is developed for ultimate time frame, the system so developed is tested for intermediate time frame i.e. 2006-2007 conditions. For this purpose Following Generating units likely to be commissioned during XI plan period were deleted along with associated transmission lines.

Kutch Region

Mundra (stage - II)	500 MW
Tidal	900 MW
Solar	400 MW
Mundra - Anjar	400 kV 3rd ckt.
Anjar - Morvi	400 kV D/C

North Gujarat

Parbati	500 MW
CEPA Unit 3	660 MW

Central Gujarat

Sipat unit 3	1000 MW
Gandhi Nagar (replacement)	210 MW

South Gujarat

Mangrol	500
Gandhar (GEB)	655
Kawas ext.	650
Gujarat west Coast	500

Mangrol - Navsari 400 kV T/C

Gandhar - Wagra D/C

LILO of Bharuch - Mobha 220 kV D/C line at Gandhar

Line Section	No. of Ckts.	Length (kM)	
220 Lines			
Gandhi Ngar - Nardipur	D/C	16	3rd & 4th circuits
Panandaro - Bharanda	D/C	20	
LILO of Mehsana - Anjar Ckt no. 1 at Rapar and Radhanpura		30	
Wanakbori - Kapadvanj	D/C	54	Under Const.
Kapadvanj - Ranasan	D/C	52	Under Const.
Dehgaum - Ranasan		40	Under Const.
LILO of Wanakbori - Ranasan S/C line tat Kapadvaj		10	Under Const.
LILO of Baruch - Karamsad D/C line at Paghuthan		15	Under Const.
Essar - Icchapur	D/C	16	Under Const.
Ichhapur - Sachin	D/C	25	Under Const.
LILO of one of the ckt of Vav - Navasari D/C line at Sachin		10	Under Const.
Mangrol - Kosamba (Essar) PP	T/C	46	
Kosamba - Kim	D/C	24	
Kosamba - Jagodia	D/C	48	
Kosamba - Olpad	D/C	50	
Baruch - Mobha	D/C	86	
Mobha - Karamsad	D/C	74	
Ghoga (Bhavnagar) - Shiror	S/C	70	
LILO of Bhavnagar - Karamsad D/C line at Ghoga		15	
Reliance - Rajkot	D/C	70	
Reliance - Jamnagar	2 x D/C	30	
Jamnagar - Dherol - Morvi	D/C	100	
Pipavav - Rajula - Mahuva	D/C	72	
Pipavav - Dhari	D/C	45	
Mahuva - Svarkundla	S/C	52	
Chhara - Kodinar	D/C	15	
LILO of Svarkundla - Dhakodva S/C at Dhari		15	
Zerda - Jantra	D/C	40	
Zerda - Deesa	D/C	40	
Himmat Nagar - Khedbrahma	D/C	50	
Achhalia - Rajpipla	S/C	40	
Kapadvanj - Sevalia	S/C	40	
Chronania - Sanand	S/C	75	

Line Section	No. of Ckts.	Length (kM)
Viramgam - Ranchhodpura	S/C	35
Morbi - Chardva	S/C	30
Morbi - Halvad	S/C	50
Shapur - Veraval	S/C	50
Limbdi - Jasdan	S/C	40
LILO of Jambua - Baruch at Karjan		10
LILO of Asoj - Karamsad at Kanbha		10

It is strongly recommended that with a view to preserve right of way, all 220 kV S/C lines nay be constructed on D/C towers.

6.10.3 Transmission lines required during 2002-2007

Line Section	No. of Ckts.	Length (kM)
400 kV Lines		
Anjar - Zerda	D/C	170
Nardipur - Himmat Nagar	D/C	70
LILO of Nardipur - Zerda S/C at Patan		25
TAPP Ext. - Bhilad	D/C	50
Bhilad - Navasari	D/C	80
Jetpur - Morvi	D/C	130
400 kV operation of following lines which were planned for 220 kV operation during IX plan		
Kosamba - Navasari	D/C	45
Pipavav - Jetpur	D/C	160
Pipavav - Svarkundla	D/C	64
Pipavav - Chhara	D/C	40
Chhara - Jetpur	D/C	150
220 kV Lines		
Akrimota - Panandaro	D/C	45
Bharanda - Nakhtrana	D/C	35
LILO of 2nd ckt of Panandaro - Anjar line at Panadaro		15
LILO of 2nd ckt of Anjar - Mehsana line at Radhanpura and Rapar (Ist Ckt LILOed in 9th plan)		30
Surat - Ichhapur	D/C	8
Surat - Kosamba PP	D/C	33
Stringing of 2nd ckt of following 220 kV lines		
Achhalia - Rajpipla	S/C	40
Kapadvanj - Sevalia	S/C	40
Chronania - Sanand	S/C	75
Viramgam - Ranchhodpura	S/C	35
Morbi - Chardva	S/C	30
Morbi - Halvad	S/C	50
Shapur - Veraval	S/C	50
Limbdi - Jasdan	S/C	40

6.10.4 Transmission lines required during 2007-20012

Line Section	No. of Ckts.	Length (kM)
400 kV Lines		
Anjar - Morvi	D/C	30
Nardipur - Patan	D/C	65
Mangrol - Navasan		70
Kawas Ext. - Kosamba PP	D/C	35
220 kV Lines		
Gujarat West Coast - Utran	D/C	15
Gujarat West Coast - Olpad	D/C	15
Gandhar (GEB) Wagra	D/C	22
LILO of Baruch - Mobha D/C line at Gandhar (GEB)	D/C	10

Annex - I

Installed Capacity Available by the end of IX, X & XI plan periods

Name of the power station	Installed capacity (MW)				
	Available by the end of IX plan	Additions during X plan	Total available by the end of X plan	Additions during XI plan	Total available by the end of XI plan
Ukai (H)	305		305		305
Kadana	240		240		240
Ukai (T)	850	(-) 240	610	240 (-)400	450
A E Company	780		780		780
Gandhi Nagar	870	(-) 240	630	240	870
Wanakbori	1470		1470	(-)210	1260
Sikka	240		240		240
Kutch Lignite	215		215		215
Dhuvran	Retd	534	534		534
Utran	175		175		175
GIPCIL (Baroda)	305		305		305
Sardar Sarovar Share	232		232		232
Hazira	160		160		160
Jam Nagar (Reliance)	500		500		500
Bhav Nagar	375	250	625	250	875
Chhara	600	600	1200	600	1800
Essar	515		515		515
Pipavav	655	1000	1655	655	2310
Paguthan (Gandhar)	655		655	655	1310
Mangrol	250		250	500	750
Akrimota		250	250		250
Mundra		500	500	500	1000
Surat		500	500		500
CEPA (Share)		1320	1320	660	1980
TAPP Extn (share)		500	500		500

Name of the power station	**Installed capacity (MW)**				
	Available by the end of IX plan	**Additions during X plan**	**Total available by the end of X plan**	**Additions during XI plan**	**Total available by the end of XI plan**
Gujarat West Coast				500	500
Sipat		500	500	1000	1500
Parbati Valley				500	500
Kawas Extn (GEB)				650	650
Wind		200	200		200
Kutch Tidal				900	
Solar				400	
Small thermal stations	590	610	1200		1200
Berge Mounted	130		130		130
Total (Gujarat Own)	**10112**	**6284**	**16396**	**7640**	**24036**
Share in central sector generating stations	1474		1474		1474
Additional share from unallocated central share	245				
Grand Total	**11831**		**17810**		**25510**

Share of Gujarat in Central Sector Generating Stations existing in Western Region

Name of power station	Installed capacity (MW)	Gujarat's share (MW)
VSTPS	2260	411
KSTPS	2150	360
gandhar	648	234
Kawas	645	184
Kapp	440	125
Total		**1474**

Annex - 6.2-1

Generation schedule considered in studies for 2001-2002 conditions

Power station	Installed capacity			Despatches			
	By the end of VIII plan	Additional during IX plan	Total by the end of IX plan	Normal	Special Area Max Generation in		
					North Gujarat	South Gujarat	Saurastra
Ukai (H)	305		305	225	225	225	225
Kadana (H)	240		240	150	230	150	150
Ukai (T)	850		850	540	540	740	540
A E Company	510	270	780	530	700	530	530
Gandhi Nagar	660	210	870	610	750	610	610
Wanakbori	1260	210	1470	900	1200	900	900
Sikka	240		240	175	175	175	200
Kutch Lignite	215		215	170	170	170	170
Dhuvran	588		Retd				
Utran	175		175	110	110	110	110
GIPCIL (Baroda)	305		305	250	250	250	250
Sardar Sarovar Share (H)		232	232	150	150	150	150
Hazira		160	160	150	150	150	150
Jam Nagar (Reliance)		500	500	400	350	400	450
Bhav Nagar		375	375	300	250	300	325
Chhara		600	600	450	350	450	450
Essar	515		515	450	350	450	450
Pipavav		655	655	500	350	350	600
Paguthan (Gandhar)		655	655	400	400	600	400
Mangrol		250	250	200	200	200	200
Small Diesels		590	590	415	345	65	210
Dhansura		50	50	35	35	35	35
Idar		40	40	30	30	30	
Vasana		50	50	35	35		
Chhatral		100	100	75	70		

Power station	Installed capacity			Despatches			
	By the end of VIII plan	Additional during IX plan	Total by the end of IX plan	Normal	Special Area Max Generation in		
					North Gujarat	South Gujarat	Saurastra
Kheralu		100	100	75	70	70	70
Siddhpur		50	50	35	35		35
Vadagam		40	40	30	30		30
Deodar		60	60	40	40		40
Rapar		50	50	35			35
Anjar		50	50	35			35
Berge Mounted		130	130	90			90
Muldwarka		100	100	70			70
Dahej		30	30	20			20
Total (Gujarat Own)	**5863**	**4837**	**10112**	**7245**	**7245**	**7050***	**7230**

* Generation of Gandhar (NTPC) also increased by 200 MW

Central Sector share calculations for IX plan

Central sector	Installed Cap		Despatch	Gujarat share	DNH & DD share	Summary of dispatches	
	Total	Guj. share					
VSTPS	2260	411	2034	372		Gujarat own gen	7235
KSTPS	2150	360	1710	291		Share in central sector	1395
Gandhar	648	234	400	144		UT's share	150
Kawas	645	184	600	171		Total	8780
Kapp	440	125	350	144		Gujarat loads	8640
TAPP	320	160	288	98		UT's loads	150
Total	**6503**	**1474**	**5320**	**1220**	**22 + 20**	Total loads	8790
Unallocated (15%)	975	245	807-107*	175 (25% of 700)	105	Total gen (7235+1545)	8780
Total	7478	1719		1395	150		

Total share of Gujarat + DNH + Daman & Diu = 1545

Central sector generation within Gujarat = 1350

Net import = 1545 - 1350 = 195

* Total unallocated = 15% of Despatch considered = 807 where 107 MW is Specific Allocation, so that unallocated central sector = (807-107) = 700 MW

Annex - 6.2-2

Load generation balance for the year 2006-2007

(all Fig in MW)

Name of power station	Installed capacity located in Guj.	Despatch considered	Loads	Surplus deficit	Remarks
South Zone	**5568**	**4022**	**3509**	**513**	
Ukai (H)	305	222			
Ukai (T)	610	444			
Hazira	160	116			
Essar	515	375			
Gandhar (GEB)	655	472			
Gandhar (NTPC)	648	472			Note 2
Mangrol	250	182			
Surat	500	364			
Kawas (NTPC)	645	470			Note 2
KAPP	440	320			Note 2
Tapp Extn	500	365			
Utran	175	100			
Small Thermals	165	120			
Central Zone	**4656**	**3346**	**3300**	**46**	
Wanakbori	1470	1065			
Dhuvaran	534	390			
A E Co	820	597			
GIPCL	305	225			
Sardar Sarovar	232	169			
Sipat	500	364			At Asoj
Gandhi Nagar	630	459			
Small thermal	75	55			
Berge mounted	30	22			
Wind	100				Note 1
North Zone	**2140**	**1557**	**2804**	**-1247**	
Kadana	240	175			

Name of power station	**Installed capacity located in Guj.**	**Despatch considered**	**Loads**	**Surplus deficit**	**Remarks**
CEPA	1320	960			Injection at Nardipur
Small Thermal	580	422			
Saurastra Zone	**4560**	**3320**	**2729**	**591**	
Sikka	240	175			
Reliance	500	364			
Ghoga (Bhavnagar)	625	455			
Pipavav	1655	1204			
Chhara	1200	874			
Small thermal	240	175			
Berge mounted	100	73			
Kutch Region	**1205**	**804**	**507**	**290**	
Kutch	215	156			
Akrimota	250	182			
Mundra	500	364			
Small Thermal	140	102			
Wind	100				Note 1
Total	**18129**	**13049**	**13085***	**-36**	**Note 2** *(including Tr. losses)

Note 1. Output of Solar, Wind and Tidal generating stations depend on mother nature as such power from these stations has not been considered to meet peak load demand.

Note 2. Central sector generation vis-a-vis Gujarat's share

Gujarat's total share in all Central sector generating stations	1474 MW
I C of central sector generation stations located in Gujarat (Gandhar = 648, Kawas = 645, KAPP = 440)	1733 MW
Surplus central sector power to be exported out of state	259 x 0.73 = 189 MW
Loads of DNH & Daman Diu to be incident at Bhilad	225 MW
Net central sector power to be imported to meet UT's loads	36 MW

Annex - 6.2-3

Load generation balance for the year 2011-2012

(all Fig. In MW)

Name of Power station	Installed Capacity located in Guj	Despatch considered	Loads	Surplus/Deficit	Remarks
South Zone	**7723**	**5720**	**5043**	**677**	
Ukai (H)	305	230			
Ukai (T)	450	335			
Hazira	160	120			
Essar	515	385			
Gandhar (GEB)	1310	970			
Gandhar (NTPC)*	648	480			Note 2
Mangrol	750	560			
Surat	500	370			
Kawas Extn. (GEB)	650	490			
Kawas (NTPC)*	655	490			Note 2
KAPP*	440	330			Note 2
Tapp Extn.	500	370			
Gujarat West Coast	500	370			
Utran	175	100			
Small Thermals	165	120			
Central Zone	**5836**	**4186**	**4234**	**-48**	
Wanakbori	1260	935			
Dhuvarn	534	400			
A.E.Co.	780	610			
GIPCL	305	225			
Sardar Sarovar	232	172			
Sipat	1500	1124			At Asoj
Gandhi Nagar	870	645			
Small Thermal	75	55			
Berge Mounted	30	20			
Solar	150				Note 1
Wind	100				Note 1

Name of Power station	Installed Capacity located in Guj	Despatch considered	Loads	Surplus/Deficit	Remarks
North Zone	**3300**	**2450**	**3716**	**-1266**	
Kadana	240	180			
CEPA	1980	1470			Nardipur
Parbati	500	370			Zerda
Small Thermal	580	430			
Saurastra	**6065**	**4510**	**3975**	**535**	
Sikka	240	180			
Reliance	500	370			
Ghoga	875	650			
Pipavav	2310	1715			
Chhara	1800	1340			
Small Thermal	240	180			
Berge Mounted	100	75			
Kutch Region	**2855**	**1195**	**885**	**310**	
Kutch	215	160			
Akrimota	250	185			
Mundra	1000	745			
Small Thermal	140	105			
Wind	100				Note 1
Solar	250				Note 1
Tidal	900				Note 1
Total	**25579**	**18061**	**18172***	**-111**	**Note 2 (*incld. Tr. losses)**

Note 1. Output of Solar, Wind and Tidal generating stations depend on mother nature as such power from these stations has not been considered to meet peak load demand.

Note 2. **Central Sector generation vis-a-vis Gujarat's share**

Gujarat's total share in all Central sector generating stations	1474 MW
I C of central sector generation stations located in Gujarat (Gandhar - 648, Kawas - 645, KAPP - 440)	1733 MW
Surplus central sector power to be exported out of state	259 x 0.73 - 189 MW
Loads of DNH & Daman Diu to be incident at Bhilad	300 MW
Net central sector power to be imported to meet UT's loads	111 MW

Annex - 6.3

Substation wise load demand by the end of IX, X and IX plan periods

Sub-station	Peak Load (MW)		
	2001-02	2006-07	2011-12
Kutch Region			
Anjar	128	253	443
Panandaro	20	40	69
Nakhartana	40	79	128
Rapar	38	75	131
Bharanda	30	60	104
Sub-total	**256**	**507**	**885**
North-Gujarat			
Deodar	155	222	294
Mehsana	160	229	303
Chhatral	194	277	368
Dhansura	107	153	203
Vijapur	205	293	389
Himatnagar	138	197	262
Zerda	90	129	171
Palanpur	163	233	309
Thrad	68	97	129
Jantra	126	180	239
Patan	161	230	305
Khralu	61	87	116
Jantra	62	89	118
Khedbrahma	95	136	180
Radhanpur	67	96	127
Deesa	108	154	204
Sub-total	**1960**	**2804**	**3716**
Central-Gujarat			
Kalol (Jamla)	60	83	107
Kapadvanj	60	82	107
Dehgaum	101	139	180
Viramgam	82	113	146

Sub-station	Peak Load (MW)		
	2001-02	2006-07	2011-12
Gotri	199	274	354
Fertilizer	68	94	121
Nandesari	119	164	212
Jawahar Nagar	104	143	185
Dhanduka	11	15	20
Vatwa	110	152	196
Ranasan	80	110	142
Karamsad	255	351	453
Jamua	204	281	363
Halol	46	63	82
AECO	500	689	889
Mobha	110	152	197
Savli	25	34	45
Kanbha	20	28	36
Jotna	50	69	89
Ranchhod	46	63	81
Savaliya	40	55	71
Sub total	**2394**	**3300**	**4234**
South Gujarat			
Wagra	47	72	104
Haldwara	90	139	200
Achhalia	110	170	244
Ukai (H)	58	89	129
Valthan	305	470	676
Navsari	370	571	820
Vapi	235	362	521
Kim	140	·216	310
Utran	118	182	261
Ichhapur	100	154	221
Karjan	67	103	149
Bhilad	181	279	401
Wagadia	53	82	117

Sub-station	Peak Load (MW)		
	2001-02	2006-07	2011-12
Chikhli	47	72	104
Sachin	120	185	266
Zagadia	120	185	266
Rajpipla	38	59	84
Olpad	76	117	168
Sub Total	**2275**	**3509**	**5043**
Saurastra Region			
Limdi	140	213	310
Chradva	71	108	158
Sanand	31	47	69
Dhakodva	66	100	147
Bhatia	46	70	102
Jetpur	101	154	224
Keshod	47	72	104
Kodinar	81	123	180
Savarkundla	125	190	277
Bhav Nagar	120	183	266
Gondal	64	98	142
Motipanali	44	67	98
Darangdhra	97	148	215
Morbi	48	73	107
Chotila	30	46	67
Palitana	30	46	67
Vishvadhra	39	59	86
Sardargaarh	40	61	88
Rajkot	109	166	242
Jamna	35	53	78
Dhasa	30	45	67
Mahuva	80	122	178
Rajula	38	58	84
Dhari	19	29	42
Halvad	26	39	57

Sub-station	**Peak Load (MW)**		
	2001-02	**2006-07**	**2011-12**
Veraval	25	38	56
Shiror	48	73	107
Dhrol	27	41	60
Jasdan	86	131	191
Sub total	**1790**	**2729**	**3975**
Total substation wise load demands*	**8669**	**12849**	**17853**
Less load of UTs	(-) 150	(-) 225	(-) 300
Net loads of Gujarat	8519	12624	17553
EHV Tr. losses	121	236	319
Total system loads	**8640**	**12860**	**17872**

* includes loads of UTs of Dadra Nagar and Haveli and Daman & Diu

Annex - 6.4

List of existing transmission lines in Gujarat grid
(At 132 kV and above)

From Bus	To Bus	Ckt.No.	Voltage (kV)	Length (Km)	Per unit parameters		
					Res	Reac	Susp
400 kV lines							
LIMDI	JETPUR	1	400.00	161.00	.0030	.0332	.8884
LIMDI	ASOJ	2	400.00	166.00	.0031	.0344	.9216
INDOR4	ASOJ	2	400.00	273.00	.0051	.0566	1.5157
ASOJ	WANAKBORI	1	400.00	75.00	.0014	.0154	.4108
WANAKBORI	SOJA	2	400.00	97.00	.0018	.0200	.5340
ASOJ	UKAI	1	400.00	139.00	.0026	.0286	.7640
ASOJ	JETPUR	1	400.00	311.00	.0058	.0643	1.7211
220 kV lines							
WANAKBORI	KAPADWANJ	1	220.00	47.00	.0074	.0374	.605
KAPADWANJ	RANASAN	1	220.00	55.00	.0087	.0440	.0712
GANCS2	HARDWARA	2	220.00	13.00	.0021	.0104	.0175
TAPS2	VAPI	1	220.00	83.00	.0132	.0665	.1076
VAPI	NAVSARI	1	220.00	81.00	.0129	.0648	.1048
NAVSARI	VALTHAN	2	220.00	33.00	.0052	.0266	.0430
MEHSANA	DEODHAR	1	220.00	125.00	.0194	.1030	.1778
DEODHAR	ANJAR	1	220.00	235.00	.0364	.1936	.3344
MEHSANA	ANJAR	1	220.00	280.00	.0434	.2307	.3984
PANANDRAO	ANJAR	2	220.00	170.00	.0264	.1400	.2419
SOJA	PALANPUR	2	220.00	99.00	.0158	.0790	.1277
PADADPUR	ZERDA	1	220.00	41.00	.0066	.0332	.0538
SOJA	VIJAPUR	1	220.00	25.00	.0040	.0200	.0323
JETPUT	KESHOD	1	220.00	78.00	.0124	.0623	.1008
JETPUT	KESHOD	2	220.00	78.00	.0124	.0623	.1008
KESHOD	KODINAR	1	220.00	65.00	.0101	.0536	.0924
KODINAR	SVARKANDLA	1	220.00	104.00	.0165	.0831	.1344
VALTHAN	KIM	1	220.00	41.00	.0066	.0332	.0538
HARDWARA	JAMBUA	1	220.00	40.00	.0068	.0305	.0421
JAMBUA	VALTHAN	1	220.00	121.00	.0192	.0964	.1559
HARDWARA	KIM	1	220.00	60.00	.0093	.0495	.0854
UTRAN	KIM	2	220.00	26.00	.0041	.0208	.0336

From Bus	To Bus	Ckt.No.	Voltage (kV)	Length (Km)	Per unit parameters		
					Res	Reac	Susp
UKAI (T)	VALTHAN	2	220.00	64.00	.0102	.0516	.0833
WANAKBORI	RANASAN	1	220.00	81.00	.0130	.0648	.1048
WANAKBORI	ASOJ	2	220.00	81.00	.0130	.0499	.1048
WANAKBORI	DHANSURA	2	220.00	62.00	.0099	.0132	.0806
GANDHINAGAR	SOJA	2	220.00	16.00	.0026	.0315	.0215
SOJA	MEHSDHANSURA ANA	4	220.00	39.00	.0063	.0362	.0510
ASOJ	KARAMSAD	2	220.00	44.00	.0068	.0416	.0626
JAMBUA	KARAMSAD	2	220.00	52.00	.0082	.0873	.0672
KARAMSAD	HARDWARA	2	220.00	109.00	.0174	.0873	.1411
KAKARA2	HARDWARA	2	220.00	73.00	.0113	.0602	.1039
KAWAS2	HARDWARA	2	220.00	81.00	.0126	.0667	.1153
KAWAS2	ICHHAPUR	1	220.00	8.00	.0012	.0066	.0114
KAKRA2	VAPI	2	220.00	118.00	.0183	.0972	.1679
KAKRA2	VALTHAN	2	220.00	45.00	.0070	.0371	.0640
KAWAS2	VALTHAN	1	220.00	36.00	.0056	.0297	.0512
ICHHAPUR	VALTHAN	1	220.00	28.00	.0044	.0231	.0398
KAWAS2	NAVSARI	2	220.00	46.00	.0071	.0379	.0655
ACHALIA	UKAI (H)	2	220.00	83.00	.0128	.0684	.1181
UKAI (T)	ACHALIA	3	220.00	83.00	.0129	.0684	.1181
ACHALIA	JAMBUA	4	220.00	47.00	.0072	.0388	.0669
JAMBUA	ASOJ	1	220.00	24.00	.0038	.0198	.0342
JAMBUA	WAGHODRA	1	220.00	19.00	.0029	.0157	.0270
ASOJ	WAGHODRA	1	220.00	25.00	.0039	.0206	.0356
KARAMSAD	RANASAN	2	220.00	70.00	.0108	.0576	.0996
KARAMSAD	VARTEJ	2	220.00	208.00	.0322	.1714	.2960
VARTEJ	SVARKANDLA	1	220.00	93.00	.0146	.0755	.1338
SVARKANDLA	JETPUR	1	220.00	96.00	.0152	.0765	.1236
JETPUR	GONDAL	2	220.00	27.00	.0044	.0216	.0349
JETPUR	RANVAV	2	220.00	109.00	.0174	.0872	.1411
GONDAL	LIMDI	1	220.00	110.00	.0171	.0906	.1556
LIMDI	KARAMSAD	1	220.00	118.00	.0183	.0972	.1680
CHATRAL	GANDHINAGAR	2	220.00	28.00	.0044	.0230	.0398
CHATRAL	VIRAMBAG	1	220.00	41.00	.0066	.0332	.0538
VIRAMBAG	LIMDI	1	220.00	70.00	.0112	.0565	.0914

From Bus	To Bus	Ckt.No.	Voltage (kV)	Length (Km)	Per unit parameters		
					Res	Reac	Susp
ASOJ	HALOL	2	220.00	32.00	.0050	.0262	.0455
HALOL	GODHRA	2	220.00	35.00	.0054	.0288	.0455
GODHRA	KADANA	2	220.00	83.00	.0312	.0664	.1075
KADANA	DHANSURA	2	220.00	78.00	.0124	.0623	.1008
HIMMAT NGR	VIJAPUR	1	220.00	36.00	.0058	.0291	.0470
GODHRA	WANAKBORI	1	220.00	36.00	.0058	.0291	.0470
UKAI (H)	UKAI (T)	2	220.00	6.00	.0010	.0050	.0085
GANDHINAGAR	RANASAN	2	220.00	20.00	.0032	.0164	.0285
DHANSURA	HIMMAT NGR	1	220.00	34.00	.0055	.0274	.0444
LIMDI	DHRAN	2	220.00	68.00	.0109	.0548	.0888
NASIK2	NAVSARI	2	220.00	138.00	.0178	.1323	.2039
TAPS2	NAVSARI	1	220.00	156.00	.0248	.1247	.2016
JAMBUA	DHANDI	1	132.00	5.00	.0013	.0206	.0361
JAMBUA	KARAMSAD	2	132.00	5.00	.0013	.0206	.0361
DHUVRAN	DHUVRAN	2	132.00	93.00	.0774	.2300	.0500
DHUVRAN	AECOM	2	132.00	22.00	.0142	.0616	.0140
VATWA	RANASAN	2	132.00	50.00	.0418	.1242	.0270
RANASAN	AECOM	2	132.00	12.00	.0102	.0304	.0066
VATWA	RANASAN	2	132.00	24.00	.0202	.0598	.0130
SIKKA	JAMNAGAR	2	132.00	29.00	.0207	.0806	.0175
SIKKA	WANKANER	1	132.00	83.00	.0689	.2047	.0446
BHATIA	RANAVAV	1	132.00	14.00	.0033	.0530	.0933
JAMNAGAR	WANKANER	1	132.00	112.00	.0929	.2760	.0600
WANKANER	ANJAR	1	132.00	151.00	.01254	.3726	.0810
WANKANER	LIMDI	2	132.00	88.00	.0728	.2162	.0470
SIKKA	BHATIA	1	132.00	65.00	.0542	.0610	.0350
RANAVAV	GONDAL	1	132.00	136.00	.1122	.3335	.0726
DHANDI	PALIAD	2	132.00	57.00	.0472	.1402	.0305
GONDAL	PALIAD	2	132.00	139.00	.1153	.3427	.0466
JAMBUA	JAWNG	2	132.00	35.00	.0286	.0852	.0185
DHUVRAN	LIMDI	2	132.00	108.00	.0890	.2646	.0575
JAWNG	FERTILIZER	2	132.00	7.00	.0054	.0160	.0035
FERTILIZER	ASOJ	2	132.00	26.00	.0216	.0644	.0140
FERTILIZER	GOTRI	2	132.00	7.00	.0062	.0184	.0040

From Bus	To Bus	Ckt.No.	Voltage (kV)	Length (Km)	Per unit parameters		
					Res	Reac	Susp
JAWNG	NANDESARI	2	132.00	7.00	.0062	.0184	.0040
NANDESARI	GIPCL	2	132.00	1.00	.0004	.0050	.0012
NANDESARI	ASOJ	2	132.00	36.00	.0294	.0874	.0190
GOTRI	DHUVRAN	2	132.00	43.00	.0356	.1058	.0230

Annex - 6.5

Sub-station wise shunt requirement in GEB grid
(Corresponding to 2002 conditions)

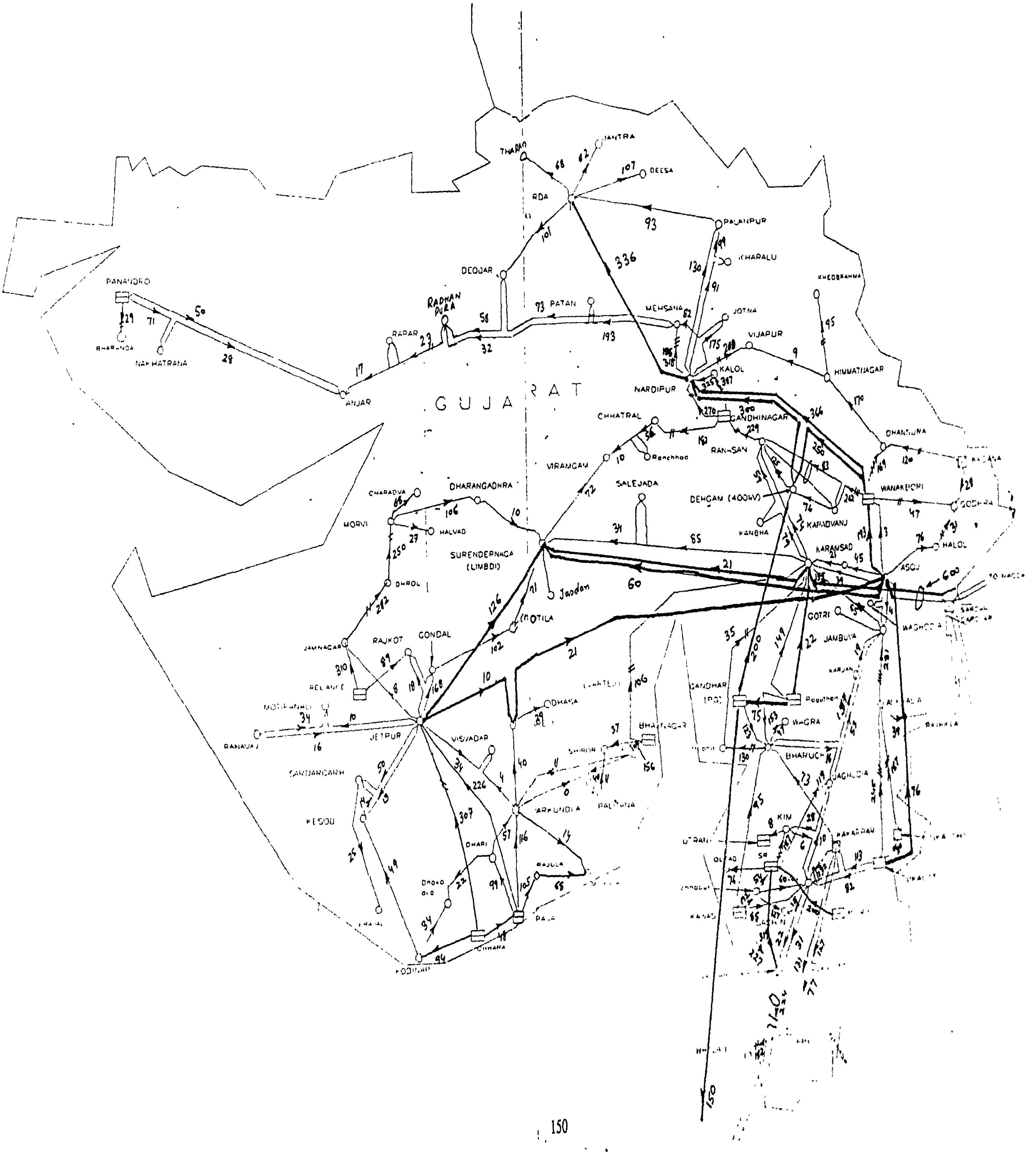
Name of sub-station	Voltage		Shunt compensation	
	P.U	KV	P.U	MVAR (effective)
159HALOL2 3	.9875	217.26	.1000	9.75
164KRMSD1 3	1.0306	136.04	1.0000	106.21
166JAMBU1 3	.9775	129.04	.2000	19.11
170MOBHA2 3	.9823	216.10	.2000	19.30
71SAVLI2 3	.9921	218.26	.2000	19.69
73SAVALY 3	.9922	218.28	.2000	19.69
167WGCIA2 4	.9781	215.19	.2000	19.13
191KARJN2 4	.9754	214.58	.3000	28.54
192WAGRA2 4	.9869	217.11	.1000	9.74
194ACH-12 4	.9882	217.41	.3000	29.30
195ZGDIA2 4	.9774	215.04	.3000	28.66
196UKAIH2 4	.9606	211.33	.4000	36.91
199 KIM2 4	.9898	217.76	.1000	9.80
200UIRAN2 4	.9558	210.27	.3000	27.41
201VALTH2 4	.9534	209.14	.1000	9.09
202VAVSA2 4	.9566	210.45	1.1000	100.66
203 VAPI2 4	.9483	208.63	1.1000	98.93
204ICHPR2 4	.8920	196.23	1.5000	119.34
205BHILD2 4	.9625	211.76	.1000	9.26
206CHKLI2 4	.8815	193.93	1.2000	93.25
211SACHN2 4	.9361	205.94	.2000	17.52
22RAJPIP 4	.9528	209.61	.4000	36.31
213OLPAD2 4	.9754	214.59	.2000	19.03
174SANAND 5	.9572	210.58	.3000	27.49
31CHRDV2 5	1.0022	220.49	.2000	20.09
232BHATI2 5	1.0107	222.36	.4000	40.86
236JETPR2 5	.9772	214.98	.2000	19.10
239KESHD2 5	.9934	218.54	.2000	19.74
241VERAVL 5	.9913	218.08	.2000	19.65

Name of sub-station	Voltage		Shunt compensation	
	P.U	KV	P.U	MVAR (effective)
248RAJULA 5	.9898	217.75	.2000	19.59
250SAVKU2 5	.9926	218.37	.3000	29.56
250SSAVKU2 5	.9861	216.94	.5000	48.62
91BARND 1	1.0065	221.43	.2000	20.26
92NKTRN2 1	1.0047	221.84	.3000	30.28
93ANJAR2 1	.9966	219.24	1.0000	99.31
94RAPAR2 1	.9875	217.26	.2000	19.50
101DEODR2 2	.9744	214.38	.8000	75.96
102RDNPR2 2	.9758	214.67	.3000	28.56
103DEESA2 2	.9707	213.55	.5000	47.11
104THARD2 2	.9734	214.14	.3000	28.42
106ZERDA2 2	.9790	215.37	.8000	76.67
107PLNPR2 2	.9749	214.48	.7000	66.53
108KHRLU2 2	.9792	215.42	.2000	19.08
109PATAN2 2	.9664	212.62	.8000	74.71
11OMBHSA2 2	.9809	205.87	.8000	76.96
111JOTNA2 2	.9812	215.87	.4000	38.51
114CHAAT2 2	.9880	217.36	1.0000	97.61
116HIMTN2 2	.9720	213.84	.5000	47.24
117JANTRA 2	.9731	214.08	.2000	18.94
118KDBRM2 2	.9624	211.73	.4000	37.05
119VIJPR2 2	.9908	217.97	1.5000	47.24
148DHNSR2 2	.9816	215.94	.2000	19.27
136RANCHO 3	.9849	216.69	.2000	19.40
137VIRAM2 3	.9877	217.30	.5000	48.78
138SLJDA2 3	.9880	217.35	.1000	9.76
139KALOL2 3	.9935	218.58	.3000	29.61
140AECO1 3	1.0055	132.73	2.3000	232.56
142RANSN2 3	.9939	218.66	.4000	39.52
144DHGAM2 3	.9941	218.69	.3000	29.64
145KPDVJ2 3	.9943	218.74	.2000	19.77
150GOTRI1 3	.9642	127.28	.5000	46.49
151FERTLI 3	.9650	127.37	.3000	27.93
152NANDIL 3	.9667	127.60	.3000	28.04

Name of sub-station	Voltage		Shunt compensation	
	P.U	KV	P.U	MVAR (effective)
153JWHRN1 3	.9634	127.17	.3000	27.84
157VAIWAI 3	.9829	129.74	.4000	38.64
158GODHR2 3	.9870	217.14	.2000	19.48
252BHVNG2 5	.9753	214.56	.3000	28.53
255DHASA2 5	.9886	217.50	.1000	9.77
258GDNDL2 5	.9872	217.17	.1000	9.74
259RJKOT2 5	.9897	217.74	.2000	19.59
260CHTLA2 5	.9945	218.80	.2000	19.78
264DRGDR2 5	1.0046	221.01	.5000	50.46
266MORBI2 5	1.0129	222.84	.8000	82.08
267JAMNAG 5	1.0069	221.53	.1000	10.14
268HALVAD 5	1.0137	223.01	.2000	20.55
269DHROL2 5	1.0084	221.84	.2000	20.34
270JASON2 5	.9978	219.62	.5000	49.78
		TOTAL	**32.90**	**3138.91**

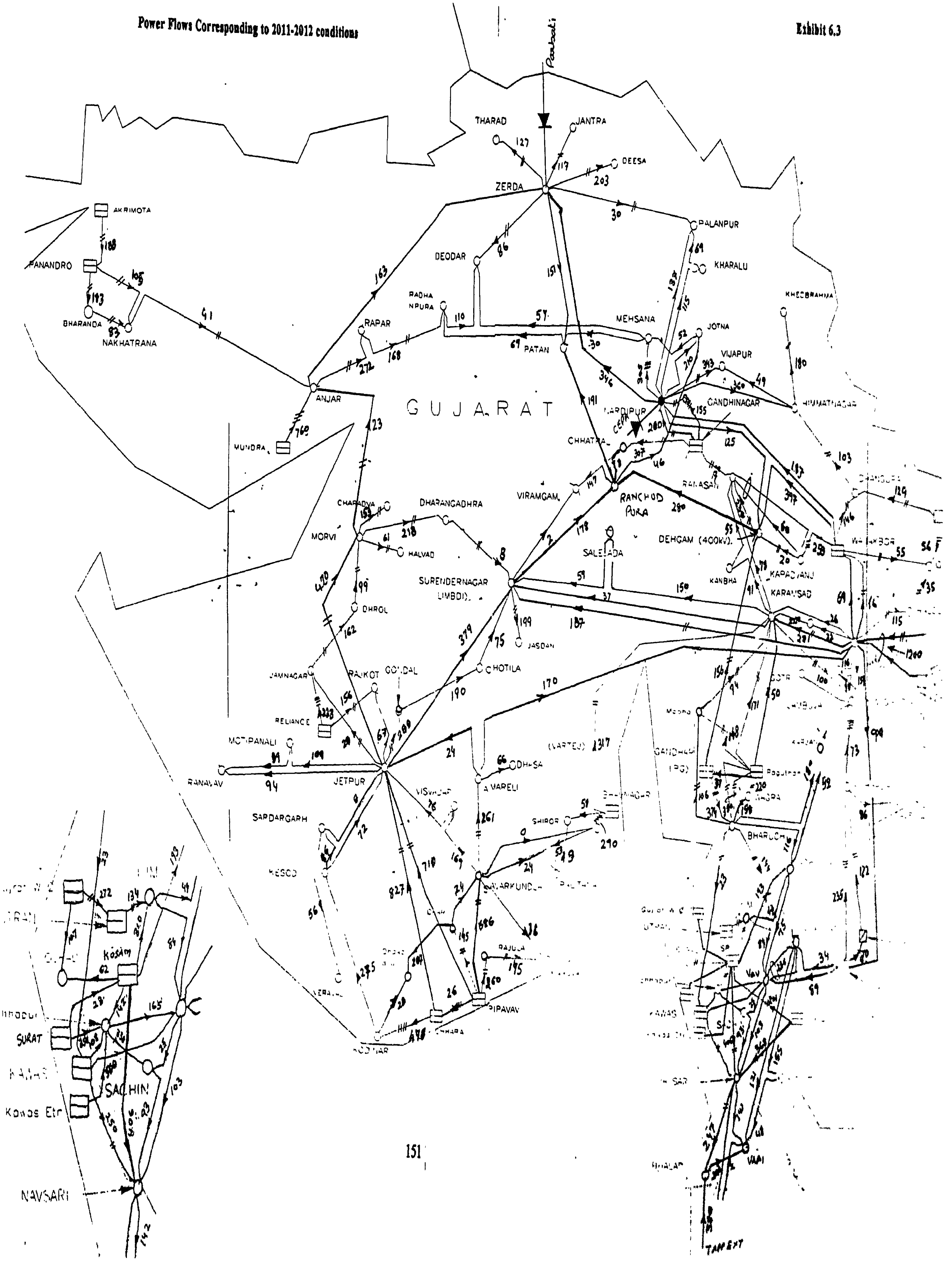
Exhibit 6.2

Power Flows Corresponding to 2001-2002 Conditions



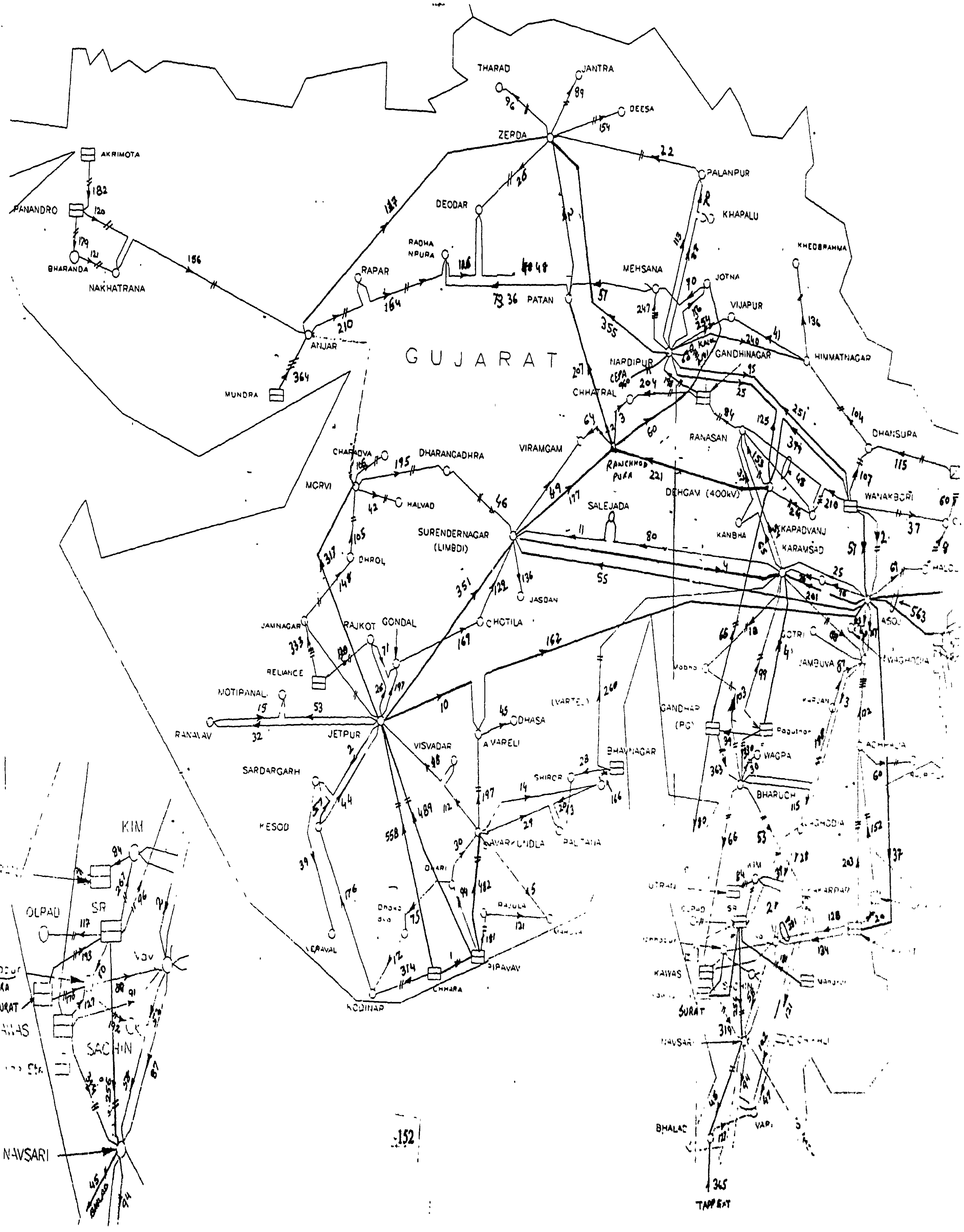
Power Flows Corresponding to 2011-2012 conditions

Exhibit 6.3



Power Flows Corresponding to 2006-2007 conditions

Exhibit 6.4



CHAPTER 7

Reduction of T&D losses

7.1 Introduction

There is a worldwide concern at the rapidly diminishing sources of energy, which has led to the realization of the need to develop the renewable sources of energy as well as the necessity to minimize wasteful uses of energy. In this context, the excessive transmission and distribution losses in Gujarat power system is a matter of concern. Present (1995-96) T&D loss figure 19% although lower than the national average of about 22% is still not only high in comparison to corresponding figures ranging from 6% to 11% in developed countries but also in comparison to many developing countries e.g. China (10%), Thailand (11%), Taiwan (7%). There is therefore an urgent need to make an in-depth study of the problem and identify the factors responsible for this state of affairs.

A study of the dispersal of the large load centres across the state shows that about 80% of the load concentration is in the South-eastern portion of the state comprising the Northern, Central and Southern Zones of the GEB. Out of the balance 20%, about 19% load concentration is in the Western zone (Saurastra area) and only 1% in Kutch zone. The development of the T&D system of GEB has also taken place accordingly - the dispersal of the Grid substations being as below:

	No of 400 kV substations	No of 220 kV substations	No of 132 kV substations	No of 66 kV substations
North, South & Central Zone	4	30	28	327
Western (Saurashtra Zone)	1	10	10	101
Kutch Zone	-	2	3	39

By and large all the generating sources (including the grid substations where power from NTPC, etc is received) are located in areas lying in the Eastern half of the state. This concentration of generating sources and load centres in the Eastern Gujarat has the following ramifications in so far as the development of T&D system and T&D losses are concerned:

i. Strategy for reduction of T&D losses should be examined first to the feasibility of upgrading some of the heavily loaded 132 kV sections for operation at 220 kV in a phased manner. Similarly a phased program could be drawn up for upgradation of 66 kV system for operation at 132 kV. This strategy would be cost-effective both from right-of-way as well as technical considerations.

ii. As far as Western Gujarat Transmission system is concerned, the load centres are located at the tail-end of the Gujarat system and are connected with Eastern Gujarat system by means of long 220 kV lines as well as two 400 kV lines converging to Jetpur 400 kV substation. Thus it appears that setting up a fairly large thermal station in the coastal areas of this region (Pipavav, Dahej, Chassa, Mundri, Sikka etc) would improve the power supply considerably both in terms of quality and reliability. Setting up of load-centre thermal stations in the central and northern regions would also help in reducing the losser. Detailed discussions on the various aspects of T&D losses of Gujarat are covered in the following paragraphs.

7.2 Transmission and distribution losses in Gujarat: Present status and potential for reduction

The approximate T&D losses and the probable break-up of transmission and distribution losses in the GEB power system in 1996/97 are expected to be as follows:

Transmission losses (400 kV, 220 kV & 132 kV)	6.5%
Distribution losses (66 kV, 11 kV & 400 volts)	12.5%
Total	19%

Compared to the transmission losses in most of the other SEB systems in India, which lies in the range of 4-4.5%, the transmission losses in Gujarat system are high. This is basically due to the reason that Gujarat is located at the tail of the Western Regional grid and is served by comparatively long EHV transmission lines emanating from the NTPC super-thermal stations located at Korba and Vindhyachal (MP) etc. At the intrastate level also because of the relative location of the super-thermal power stations with respect to the load

centres transmission of bulk power over fairly long distances are involved over 220 kV & 440 kV lines. Steps have therefore to be initiated for strengthening the EHT transmission system. As regards distribution losses, figure of 12.5% although comparatively lower than that prevailing in most of the other states is on the high side compared to those in some of the other developing countries. The higher losses are primarily due to unplanned extensions of the distribution lines, overloading of the system elements like transformers, conductors etc and lack of adequate reactive power support. By undertaking suitable system improvement schemes based on computer studies it should be possible to bring down the technical losses in the distribution system to the level of 7.5%-8% i.e. a reduction of around 5%. It may be noted that the above figures of losses are the overall losses for the state as a whole, and there might be a number of pockets (in both urban and rural areas) spread all over the state where the losses are much higher than the state average.

According to a World Bank Study on optimization of electric power distribution losses in the developing countries, maximum limit of T&D losses should be of the order of 15.5% and an achievable target should be around 8.25%. A break-down of these losses at various voltage levels are given in the following table.

Sl. No.		T&D losses (max limit)	W.B. Report* (Target)
1.	E H V Lines & sub-stations	4.0	2.0
2.	Sub-transmission lines and sub-stations	4.5	2.25
3.	11 kV distribution lines and sub-stations	5.0	3.0
4.	L T distribution system	2.0	1.0
	Total	15.5	8.25

* Source: World Bank Report on optimization of Electric Power Distribution Losses.

In the All-India context CEA in their "Report on perspective of National Power Development" have recommended that efforts have to be made to reduce the T&D losses from the level of about 23% at the end of 8th plan period (1996/97) to about 18% by the end of 10th plan (2006/07) - i.e. a reduction of about 5% over a period of 10 years. This may however be considered to be a rather ambitious program considering the paucity of funds availability for power sector as a whole and T&D sector in particular. However in the meantime there has been a sea-change in the Government's strategy for power development in the country. Generation sector has already been thrown open to the private sector and similar policy for T&D is also expected to be adopted. In view of this significant development

it may not be unrealistic to presume that CEA's program of achieving a T&D loss reduction of 0.5% per year would be possible to achieve.

Since by 1995/96 Gujarat's level of T&D losses is around 19%, the target to be achieved by the end of 11th plan (2007-12) could be fixed at about 11.5 to 12%. Thus assuming a baseline T&D loss of 19% by 1996/97 a tentative program of T&D losses to be achieved in the Gujarat system covering the 9th, 10th and 11th plan period could be fixed on the following lines:

Program of T&D Loss achievement targets

	Trans Losses	Distribution Losses	Overall T&D Losses
8th plan end (1996/97)	6.5%	12.5%	19.0%
9th plan end (2001/02)	5%	11.5%	16.5%
10th plan end (2006/07)	4.5%	9.5%	14.0%
11th plan end (2011/12)	4.0%	7.5%	11.5%

7.3 Factors responsible for excessive T&D losses

The main factors considered to be responsible for the high T&D losses in Gujarat power system could be broadly classified in the following three categories in order of relative importance:

- Financial
- Administrative
- Technical

Details of the above three factors causing unduly high T&D losses in Gujarat power system is elaborated below.

7.3.1 Financial Factors

In general in the sphere of planning for power development in India, there has been a general lack of appreciation amongst the planners about the importance of providing adequate transmission and distribution facilities to match with the additional generation capacity being inducted in the power system. The fund allocations for the T&D systems during the various Five-Year Plans were not made on rational basis but on the vague assumption that some sort of patchwork in the existing transmission and distribution network would some how meet the requirements. According to the Report of the "Rajadhyaksha Committee on Power" appointed by Government of India in 1978, for the development of a well balanced power system it was considered desirable to have investments in the Generation and T&D sectors in the ratio of 1:1. A study of the pattern of investments in Gujarat on these two sectors is indicated in Table 1.

Table 1. Plan-wise details of investment in power sector in India

Sl No.	Plan period	Total investment in power sector (Rs crores)	Expenditure incurred (Rs in Crores)			Ratio between Gen. and T&D
			Gen.	T&D	Others	
1	1st Plan (1951-56)	260	105	132	23	1:1.26
2	2nd Plan (1956-61)	460	250	115	95	1:0.46
3	3rd Plan (1961-66)	1252	777	301	174	1:0.39
4	Three Annuals (1966-69)	1223	676	291	256	1:0.43
5	4th Plan (1969-74)	2931	1505	768	658	1:0.51
6	5th Plan (1974-79)	7541	4467	2016	1058	1:0.45
7	Annual Plan (1979-80)	2473	1429	720	324	1:0.50
8	6th Plan (1980-85)	18913	12116	4706	2091	1:0.39
9	7th Plan (1985-90)	38194	24520	9783	3891	1:0.40
10	Annual Plan (1990-91)	12480	8479	2768	1233	1:0.33
11	Annual Plan (1991-92)	13769	9493	2926	1260	1:0.31
12	8th Plan (1992-97)	79589	49424	22281	7884	1:0.45

The fund allocations for T&D made especially during Fifth plan onwards has not been commensurate with the generating capacity additions in the system and has been found to be just adequate for holding the T&D losses at the prevailing level of around 23%. If the present trend of inadequate investments on T&D works were to continue in the coming plans, it would be reasonable to assume that these plan allocations would be just adequate to cater to the T&D requirements corresponding to generating capacity additions during the relevant plan periods and would be able to just limit the T&D losses to the current level of 23%. For implementing any programme for reduction of losses to lower levels, say to 18% by the end of Tenth plan period (2006-07) as recommended by CEA in their "Report on perspective of National Power Development", additional funds would be needed by the utilities to enable them to undertake necessary system improvement works.

As far as Gujarat State is concerned the plan-wise details of the pattern of investment in their power sector covering the period 1961 to 1997 i.e. from 3rd plan (1961-66) up to 8th plan (1992-97) is at Appendix 7.1 It is seen that over the above period against the total investment of Rs 2968 crores on generation, the investment of on transmission has been of the order of Rs 2843 crores - i.e. a ratio of 1:0.96 as between Generation & Transmission, which might be considered to be an ideal proportion of investment recommended by

Rajadhyaksha Committee. However inspite of this, the T&D losses are quite high (19%). A further analysis of the position in regard to the break-up of the total capacity available for meeting Gujarat loads however reveals the following picture:

Sl. No.		MW
1.	GEBs power stations (including GIPCL)	4345.00
2.	Ahmedabad Electricity Co.	550.00
3.	GIPCL	145.00
4.	Share in NTPC stations, Kakrapar SPS share & share in Tarapur Nuclear Station	1100.50
	Total	6140.50

Source. GEB Generation Deptt. report: "Information & Achievements (1995-96)".

This shows that about 18% of Gujarat's power needs are met from outside sources. This means that while the investment for T&D sector in Gujarat might be considered adequate for handling its own generation, this is not sufficient to cover the fund requirements for providing extra T&D facilities required for transmitting and distributing the additional 18% of power delivered to Gujarat system from outside agencies at grid substations on the periphery of the state boundary and located for away from the load centres. To this extent there has been a distortion in the pattern of investments on T&D vis-a-vis Generation sector in the state.

7.3.2 *Administrative*

a. Although the Indian Electricity Act has recently been amended to make theft of electricity a cognizable offence, it has been reported by the utilities that due to certain legal loopholes in regard to corresponding provision in the Indian Penal Code, the percentage of successful prosecutions has been very low. Steps have to be taken for taking remedial measures for plugging these legal loopholes.

b. In a majority of cases involving theft of electricity, connivance of the staff of the utilities cannot be ruled out. Suitable transfer policy to counter the possibility of distribution staff developing vested interests has to be formulated.

c. Deterrent punishment for errant staff and incentive schemes for honest and meritorious

staff.

d. Fixing up of responsibility at level of senior Engineers for accounting of energy received and energy billed feeder-wise. This should not be difficult in GEB system, since it is understood that metering facilities at 11 kV level on the 66/11 kV Distribution Transformers are already available.

e. Review the policy of 'flat-rate power supply', which encourages wastage of electricity. Possibly even if power is supplied on flat-rate basis, electricity meters could be provided for energy accounting purposes. This measure would also help in initiating necessary technical remedial measures.

7.3.3 Technical Factors

a. Development of weak and inadequate sub-transmission and distribution system basically due to lack of adequate investments on system-improvement works.

b. Implementation of large-scale rural electrification programme in the state involving extension of supply to low power factor loads (e.g. irrigation tube-well motors) over very long lines without providing necessary reinforcements to the back-up sub-transmission system. This has resulted in unplanned and haphazard growth of the distribution system.

c. Higher transformation losses due to the existence of the many stages of transformation viz 132/66 kV, 66/11 kV, and finally 11 kV/0.4 kV.

d. Adoption of an inappropriate distribution technology viz low voltage distribution system which is suitable for countries with high load densities (like European Countries) and not for a large country like India with loads thinly spread over wide areas. For India, high voltage distribution system is more appropriate which is the system adopted by USA and Canada with load density conditions similar to ours.

e. Inadequate reactive compensation in the system.

f. Unmetered supply to rural/agricultural loads and small domestic consumers encouraging wasteful use of electricity.

g. Poor quality electricity meters and lack of adequate calibration facilities.

h. Pilferage of electricity.

7.4 Remedial Measures: Strategies

There are two components of the T&D losses viz., non-technical and technical losses which are to be tackled independently. Strategy for reduction of non-technical losses involves administrative measures and the latter requires technical measures. For reduction of non-technical losses ut-most priority should be given towards improved and efficient monitoring system and motivating the personnel who are carrying out the measures. Some of the administrative measures that should to be taken are as under:

i. Supplying energy to all consumers through energy meters only.

ii. Undertaking a phased program for calibration and replacement of incorrect energy meters and installation of tamper proof meter boxes.

iii. Checking of current Transformers and potential Transformers connections and the PT fuses feeding the energy meters.

iv. Intensive training to the employees to make them acquainted with various anti-pilferage measures.

v. Introducing incentive schemes for informers (including employees) of pilferage activities.

vi. Giving suitable incentives to the employees instrumental in increased revenue collections in their respective districts/areas.

As regards measures for reducing the Technical losses, it would be essential to identify the areas having excessive losses by carrying Energy Audits and formulating strategies for improvement through suitable short term and long term measures as discussed below:

Short Term Measures:

i. Identification of excessive loss areas in the Distribution system requiring immediate action for reinforcement.

ii. Installation of reliable energy meters at consumers ends as well as at sending end points of all feeders and transformers at substations.

iii. Minimizing the length of LT lines by relocation/addition of distribution substations.

iv. Augmentation of existing substation capacity and installation of additional distribution substations wherever necessary.

v. Installation of HT/LT shunt capacitors at locations for power factor correction

wherever necessary (based on systematic system studies).

vi. Adoption of energy based tariff structure for all category of consumers.

vii. Adoption of TOU tariff with incentives for consumers to utilize off-peak energy.

Long Term Measures:

i. Planning of the Secondary Transmission and Distribution System in a systematic manner taking into consideration the expected load growth during the next 8 to 10 years.

ii. Replacing the overloaded LT mains and service lines by higher sized conductors or by conversion of long distance single phase distribution to three phase system.

iii. Adoption of a tariff structure forcing consumers with motor loads to maintain their power factor to a level of at least 0.85 or higher depending upon the system requirements.

iv. Usage of amorphous core pole mounted transformers in place of existing transformers to reduce the no load losses.

v. Releasing loads of 100 kVA and above at a voltage level not below 11 kV/66 kV.

vi. Standardizing the construction practices, operation and maintenance procedures etc to derive economy in construction cost and increased reliability.

vii. Formulation of system improvement schemes based on scientific system studies using available software for revamping and improvement of the distribution system for meeting the anticipated load demands with improved level of quality and reliability of power supply.

7.5 Additional fund requirements for achieving T&D loss reduction from previous plan level

An attempt has been made to make a rough assessment of fund requirements for System Improvement (S.I.) schemes required to be taken up for reduction of T&D losses from the levels existing at the end of each plan period to lower level by the end of the next plan period.

On the basis of the experience of the last few plans, it is assumed that with the past trend of investment in the power sector, the T&D works to be executed during the relevant plan period would be just adequate to cope with the additional generating capacity inducted in the system so as to maintain the T&D losses at the current level of 19%. For reducing the

losses below this level, additional funds would be required.

Each system improvement scheme has to be essentially tailor-made in nature to meet the specific requirements of the system conditions of the particular city, town or village chosen for loss reduction programme. For example in certain areas the improvement might comprise predominantly of creating new substations and augmentation of existing transformer capacities, whereas in some other area it could be largely providing reactive compensation and redistribution of the loads amongst the neighboring feeders. Thus it is rather difficult to formulate some general norm for costs of system improvement works which could be used for estimation purposes. Further, data co-relating the investment on system improvement works with the corresponding saving in losses achieved are not readily available. However, an attempt has been to formulate a norm for purposes of enabling planners to make rough estimates of a rather preliminary nature on the basis of whatever relevant data are available.

A number of SEBs have initiated planning studies and formulated number of schemes for improvement and augmentation of distribution system mainly in urban areas with a view to reducing T&D losses and improving quality of power supply to the consumers. On the basis of these studies the SEBs have identified the system improvement works to be undertaken in these areas along with the estimated investment required for each of the specified group of areas. The results of seven such schemes covering all the five regions in the country indicating the estimated cost, technical and non-technical losses, anticipated energy saving is indicated in Table 2.

Table 2. Data regarding costs and loss reduction as per a few typical scheme reports of SEBs for strengthening and improvement of power distribution system mainly in urban areas.

Name of the scheme	Cost attributable to system improvement work (Rs Crs)	Energy saving due to reduction of technical losses (MU)
Northern Region		
Scheme A	26.31	89
Scheme B	27.80	30
Scheme C	28 48	58
Western Region		
Scheme D	50.99	78
Southern Region		
Scheme E	77.55	125
Eastern Region		
Scheme F	14.08	27
North Eastern Region		
Scheme G	4.2	3
Total	229 41	410

Source: CEA

From table 2 it will be seen that for achieving the target of an annual energy saving of 410 million kWh the total investment on the seven schemes involving improvement works in urban and semi-urban areas have been estimated as Rs.229.41 crores. On this basis, the investment required on system improvement works out to Rs.0.56 crore per million kWh of energy proposed to be saved. Considering that the work to be undertaken over fifteen year period would also cover semi-urban and rural areas rather extensively (in additional to urban areas), for our assessment we could assume a somewhat lower norm of investment, say 0.50 crore per million kWh of energy saved, since the costs involved on system improvement works for rural areas would normally be less expensive. On this basis the total plan-wise additional investments required for S.I schemes for achieving a T&D loss reduction targets suggested in para 4.2 are indicated below.

Plan-wise additional fund requirements for S.I schemes

Period	Total Energy Consumption* (MKWH)	T&D loss %	Energy Saving due to loss reduction w.r.t. prev. plan (MKWH)	Additional fund requirement Rs. Crores
8th Plan	155000	19.0	Baseline	-
9th Plan	205533	16.5	5138	2569
10th Plan	277160	14	6929	3465
11th Plan	356500	11.5	8913	4457

* Based 14th Annual Power Survey

Note: Above fund requirement figures correspond to 1995/96 price level. Suitable adjustments have to be made to cover inflation.

7.6 Conclusion

i. Existing level of T&D losses of 19% for Gujarat although lower than all-India average figure of the order of 22% is still considered to be on the high side. According to World Bank studies of optimization of Electrical power distribution losses for developing countries, the maximum limit of T&D losses should be about 15.5% and the target figure should be about 8.25%.

ii. In line with the CEA's recommendation in the "Report on perspective of National Power Development" it is suggested that a target of loss reduction of 0.5% per year could be fixed for Gujarat state during the period 1996/97 to 2011/2. With this program it should be possible to reduce the T&D losses from the present level of 19%

to 11.5% by 2011/12.

In order to remove the past inadequacies in the sub-transmission and distribution systems, improvement schemes would have to be undertaken rather extensively with the objective to reduce T&D losses and to provide electricity to greater number of population with increased reliability and quality. Strengthening of sub-transmission and distribution system would primarily involve the following:

Re-conductoring of old lines with conductors of adequate current carrying capacity.

Re-distribution of loads on the existing distribution transformers for reducing length of LT lines to the minimum requirement.

Addition of more feeders to reduce load on existing feeders

Augmentation of sub-station capacity to reduce the past shortfall and provide for growing needs of power.

Upgradation of operating voltages by conversion of 3.3 kV and 6.6 kV to 11 kV and 11 kV and 22 kV for operation at higher voltage level.

Re-routing of lines and re-location of distribution transformers at the load centres.

Introduction of high voltage distribution system and installation of low capacity distribution transformers at the consumer load centers instead of cluster formation to reduce the length of LT lines. This scheme could be implemented on a selective basis to start with based on techno-economic studies.

Installation of capacitors to improve power factor and to reduce energy losses in the system.

Installation of tamper proof meter boxes.

Installation of energy meters at various location for identifying high loss areas and carrying out energy audit. Introduction of energy accounting procedures by the utilities.

Installation of improved quality meters to enhance revenue collection.

Use of aluminum alloy conductors (AAC) selectively on sections with high distribution losses. These conductors reduce the power loss by around 7.5% due to their lower AC resistance as compared to the conventional ACSR conductors and are also less prone to theft.

Introduction of amorphous metal distribution transformers will considerably reduce the no load losses. While they are more expensive, they have about 30% less no-load loss compared to a conventional transformer.

For implementing the above programme additional funds would be needed by the

utilities to enable them to take up necessary system improvement works. It is estimated that additional funds to the tune of Rs 2570 crores, Rs 3465 crores and Rs 4460 crores would need to be provided (at 1995/96 level of prices) for 9th, 10th and 11th plan periods.

References

i. GEB Administrative Report: 1993-94

ii. World Bank Report on Optimization of Electric Power Distribution Losses

iii. "Transmission & Distribution Losses - Reduction Program & Techniques - by H.C. Mittal, Member (Power System), C.E.A

Appendix 7.1. Plan-wise details of investment in the power sector of Gujarat (GEB portion)

Sl No.	Plan period	Total investment in power sector (Rs crores) (Appd outlays for state power sector)	Revised outlays for GEB only	Expenditure incurred (GEB schemes only)				Remarks
				Generation	T&D	Others	Total	
1	1st Plan (1951-56)							
2	2nd Plan (1956-61)							
3	3rd Plan (1961-66)	46.68	69.60	36.07	18.85	10.25	65.17	
4	Three Annual Plans (1966-69)	N.A.	42.41	12.65	14.44	17.79	44.88	
5	4th Plan (1969-74)	110.00	169.01	88.76	50.46	34.05	173.27	
6	5th Plan (1974-78)	380.27(*)	290.05	149.74	91.93	47.76	289.43	(*) for 5th plan 1974-79
7	Two Annual Plans (1978-80)	92.50(*)	192.48	107.50	64.20	13.99	185.69	(*) for Annual plan 1979-80
8	6th Plan (1980-85)	964.84	882.17	602.91	232.72	69.08	904.71	
9	7th Plan (1985-90)	1466.50	1214.47	868.44	459.21	146.56	1474.21	
10	Two Annual Plan (1990-92)	489.78	777.51	496.01	411.37	95.36	1002.74	
11	8th Plan (1992-97)	2675.00	2270.62	605.66	1499.93	165.03	2270.62	Tentative for 94-95, 95-96 and Appd outlay for 96-97

CHAPTER 8

Distribution Automation: Scope for improvement in quality and reliability of power supply in Gujarat

8.1 Introduction

The present day electricity consumer is not only interested in continuity of power supply but is also highly conscious regarding the quality of power supplied to him. This is because the urban consumer is increasingly using sophisticated electrical appliances which are sensitive to fluctuations of voltage, current or frequency. Even the water pumps used by the farmers are affected by poor quality of power supply served as its performance and life are dependent on this. Thus power supply quality, reliability and customer service have become important factors for gauging the performance of the power utilities. Achieving improved customer service at the least cost to the utility has become a main concern.

Basically the power quality and reliability to a large degree is affected by the cumulative outcome of deficiencies in the utility operations in the areas of generation, transmission and distribution. Available statistics indicate that majority of disruption of power supply as well as poor quality of electricity served to the consumers are attributable to faults in the distribution system and only a small percentage of customer outages are attributable to the generation and transmission subsystems. This is due to unplanned and haphazard growth of the distribution system in the states for implementing the massive rural electrification program undertaken by the state governments. The situation is further aggravated due to systems due to deficiencies in redundancy in the distribution system basically because of the radial nature of the network. Over and above this, the absence of automation in the monitoring, control and protection of distribution system makes the reliability poor. It is in this context that distribution automation needs to be considered.

8.2 Status of Distribution Automation Projects in other States of India

By and large for the operation of their distribution systems, in all the states of the country the system engineers are still dependent on P&T telephones, PLCC voice communication and UHF communication channels. SCADA facilities exist only in the state load despatching stations and power plant control rooms. However a number of Distribution Automation (DA) schemes are currently under implementation in a number of State Electricity Boards. Some of the schemes in urban areas which are in advanced stage are Bombay, Calcutta, Madras, Jaipur, Cochin, Thiruvananthapuram and Hyderabad. Distribution automation schemes for

rural/semiurban areas at Gachibowli (Hyderabad, A.P) and Jalpaiguri (West Bengal) are also under implementation. Quite a few of the above projects are externally funded (World Bank, ADB, OECF etc.). However, the Gachibowli DA project as well as Jalpaiguri project are being jointly funded by Deptt. of Electronics (DOE), Govt. of India, and the respective SEBs and being implemented by CMC Ltd. The Thiruvananthapuram city Distribution Automation Project funded by KSEB & DOE is being implemented by Electronic Research & Development Centre (ER & DC), Thiruvananthapuram.

8.3 Need for Distribution Automation in Gujarat System

Electricity Distribution in Gujarat is primarily is vested with the GEB except some urban areas like Ahmedabad and Surat. A study of the existing distribution system of GEB as well as discussions with their engineers reveal that the distribution systems in the various zones of the state are often stretched beyond their capacity due to lack of systematic planning. There has been phenomenal growth in electricity consumption, as well as the spread and complexity of distribution network in the state. Number of villages electrified has grown from 823 in 1961 to nearly 18,000 in 1994, and number of tubewells electrified has grown from about 5400 to 532000 over the same period; further, the energy consumption pattern has changed from a predominant industrial bias to agricultural consumption. However, although the growth of distribution system has been remarkable, the distribution losses continue to be high. Further, quality and reliability of supply need considerable improvement both in urban and rural areas. Thus with growing complexity of the distribution network in the state which are often dangerously over loaded, and consumers becoming more and more demanding and at the same time, faced with the urgent need to make utilities economically viable while supporting subsidies, it has become unavoidable for GEB to implement automation schemes.

8.4 Current status of Distribution Automation in Gujarat

The operation of distribution system is being done at present locally at the divisional level and they are constantly required to interact with other departments located at the zonal headquarters who in turn have to keep in touch with GEB's headquarters at Baroda. The function of coordination of the various system operation activities like switching on/off operation of circuit breakers, capacitors etc. fault rectification, voltage and frequency control is done manually through instructions given on PLCC voice links, telephones & VHF. SCADA systems are in use only in the State Load Despatch Station (Nardipur) & the large power stations.

It is seen therefore that as in most other states in India, full fledged distribution

automation schemes have not yet been implemented in Gujarat. It is understood that GEB is currently planning a DA system for implementation for controlling the operations of the distribution system of Anand semi-urban area.

8.5 Essential Functions of Distribution Automation Schemes

The Computer Aided Distribution Automation Scheme provides an integrated approach for monitoring, control, protection and metering of distribution network including distribution substations in the project area. Distribution Automation (DA) System, consists of intelligent devices such as Remote Terminal Units (RTUs) located at distribution substations, on feeders, and at customer location scattered over a wide geographical area to collect the distribution system data. This data is communicated over a communication network to a central real time computer system at a Distribution Control Centre (DCC). Commands are sent from the DCC to the remote locations over a communication network to operate the switch gear.

The functional requirements of Distribution Automation (DA) broadly cover the following:

i. *Substation SCADA*

This would be for operating 66 kV substations and 66 kV and 11 kV switch gear at the 132 kV substations from the Central Distribution control centre (CDCC). The main functions would be:

- To provide C.D.C.C. with updated information on the operating conditions of substations
- To allow efficient supervisory control of all the equipment at the substations
- To inform CDCC any change in the status of substation equipment and abnormal loading conditions.

ii. *Feeder SCADA*

This would enable monitoring and operating the equipment provided on the feeders from the district distribution (DCC) control center to facilitate:

- Substation load transfer and control
- Optimization of network for loss minimisation

iii. *Demand Side Management (DSM)*

The purpose is to reduce peak load incidence on the system by the control of deferrable loads like agricultural pumpsets by supplying power to a group of pumps at a time by rotation. This would be achieved by remote switching of equipment like distribution transformers, HV Spur lines etc., or remote switching function of customer equipment.

iv. *Automatic Metering*

This would enable remote collection of metering data for billing and research purposes and also for monitoring of status of metering equipment. This function would be useful for monitoring failure of metering equipment, for monitoring the energy theft and retrieving metering data in the remote mode.

8.6 Benefits of distribution system management through DA

The basic aim of DA system is to enable the utility to operate the available distribution facilities in the most optimal manner and thus help in deferring the augmentation of the existing distribution system equipments and at the same time help in offering better service to the consumers by ensuring better quality and improved reliability of service. It also helps in reducing the power losses by making effective use of voltage/VAR control devices as and when required automatically.

Briefly, the major benefits of DA scheme are:

i. Improvement in reliability of supply through speedy fault location, isolation and service restoration.
ii. Real time operation of distribution system for minimal losses and improved operational efficiency.
iii. Increased cash flow to utility through automatic metering.
iv. Reduction of commercial losses by continuous monitoring of major customers for defective metering and theft of energy.
v. Supervisory control of distribution substations with its attended benefits.
vi. Intangible benefits associated with improved reliability and quality of supply.

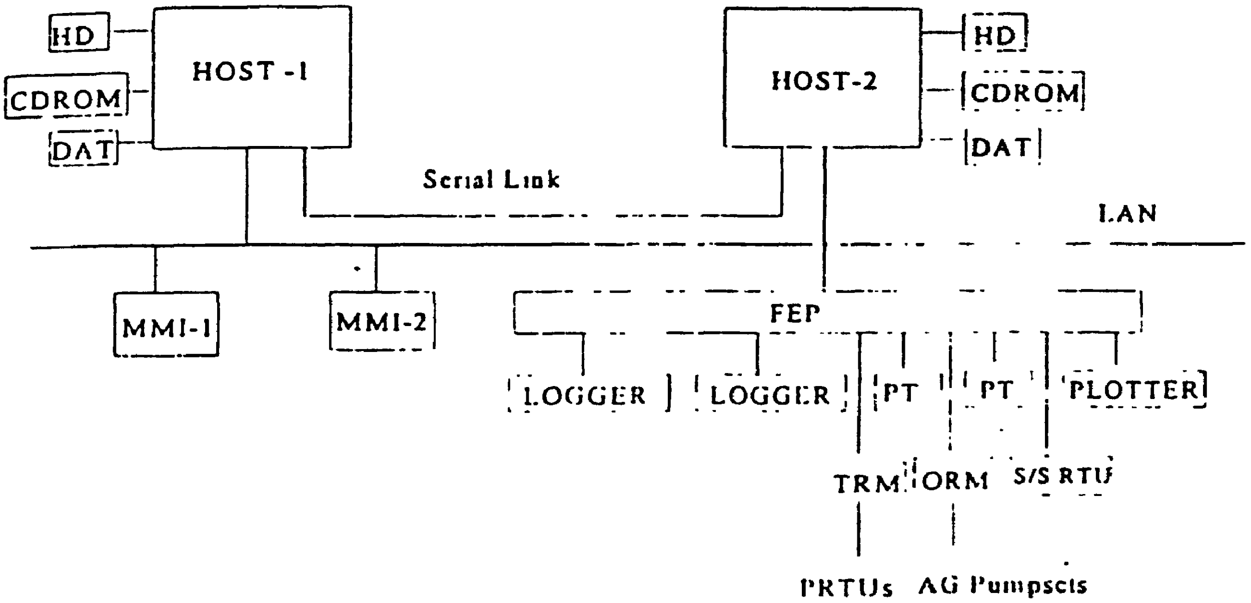


Figure -1: Schematic of a typical distribution control center

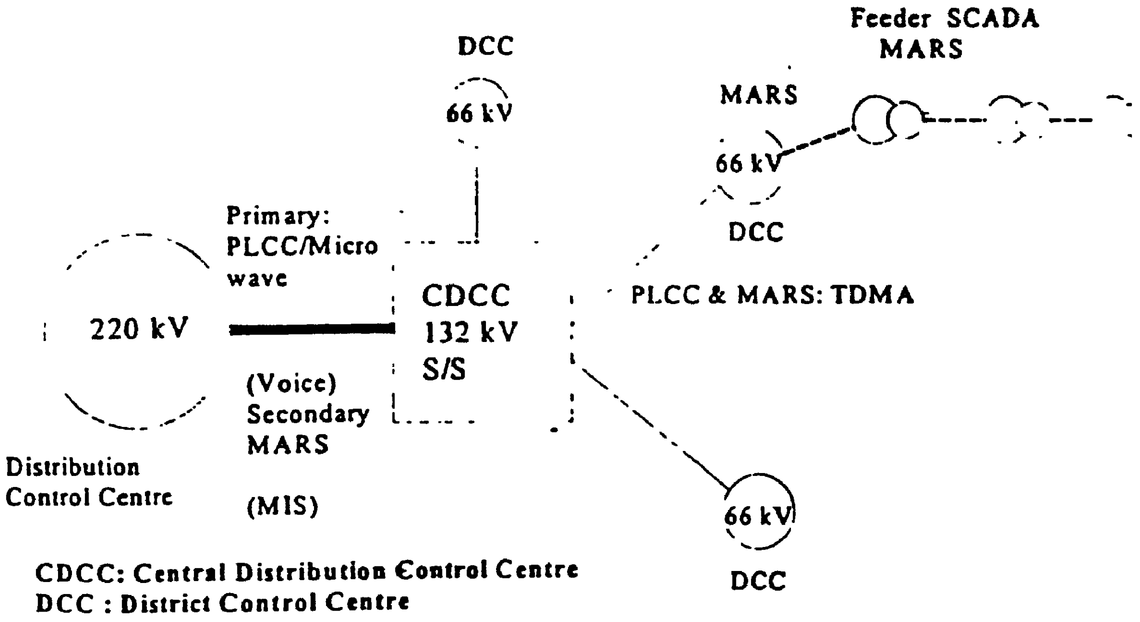


Figure 2 : Diagram showing overall plan of DA scheme in a zone.

8.7 Choice of Communication System

Currently most of the power utilities in the country by and large are dependent on Power Line Carrier Communication (PLCC) and Telephone lines for their communication needs. Experience of the utilities as well as the Regional Electricity Boards with these facilities for purposes of data as well as voice communication for load despatch and system control functions has been unsatisfactory. Therefore, for DA purposes it would not be advisable to depend exclusively on PLCC or telephone facilities, and it would be prudent to opt for UHF/VHF communication technology. As a matter of fact for some of the DA projects currently under implementation in the various states digital radio communication in UHF range at 900 MH has been adopted. The Central Ministry of Communications has earmarked 849 MHz to 953 MHz frequency range for use of the power sector in the country as a whole and this is a very positive development for successful functioning of the DA systems. Apart from this, micro-wave communication channel facilities in the 2 GHz frequency range is available for use for power sector.

As in the DA projects under implementation in India, it is suggested that Multiple Address Radio System (MARS) technology could be used for the Gujarat DA projects also with the master situated at DCC and the remotes dispersed all over the state. For Management Information Services (MIS) between the Central Distribution Control Centre, and the zonal offices of the utility micro-wave links could be established. Both the MARS and micro-wave systems could operate on Time Division Multiple Access (TDMA) mode for optimal use of available band width.

VHF communication could be adopted for one-way control of agricultural pumpsets and UHF radio switches installed at the remote locations for this purpose.

8.8 Distribution Control Centre Architecture & Components

The control centre architecture is designed to distribute functions of communication, graphics and database on different machines - Front end processors (FEP), MMI and Master computer. All the nodes are connected on LAN. Schematic of Control Centre is given in Figure 1.

The main components of the DCC and their respective functions are indicated below:

Master Computer System: Consists of two computers one of which runs the system in active state and the other acts as a standby which takes over data acquisition duties without interruption.

The local area network (LAN): Designed to inter-connect master computer, Man-Machine Interface (MMI) system and the Front End Processor (FEP) to give a distributed architecture. Data acquisition and error checking are the functions of F.E.P. Other SCADA

functions are performed by the master system. Data Loggers are connected to both the systems through F.E.P.

Man Machine Interface (MMI): Consoles are provided at the D.C.C for the operator interface. Two are on master computer system and two on dedicated work stations. The M.M.I displays single line diagrams of substation with the required analog values, alarm/even lists etc.

Programmer Terminals (PT): Provided for development/modifications.

Front End Processor (FEP): This consists of two C.P.U Boards (one main and the other hot stand by), Dual Areas Hardware Boards and power supply units. F.E.P is connected to the Host on the LAN and supports required number of synchronous channels for communication to the devices. This has built in redundancy.

Loggers: for providing hard copy records of:

- all alarms and operator control actions as and when they occur.
- periodic on demand reports. Loggers are not matrix printers connected to host system through F.E.P.

Plotters: for providing hard copy outputs of single line diagrams and maps.

Un-interruptible Power Supply (UPS): 230 volts - AC system of say 7.5 KVA with 30 minute battery back-up.

8.9 Strategy for introduction of DA in Gujarat System

One of the most important considerations to be kept in view while framing a strategy for the introduction of DA in the Gujarat system is the constrained financial condition of the GEB. In view of this it would be advisable to adopt a cautious evolutionary approach in this regard rather than plan for introduction of DA on a large scale right away.

In this context, the three step approach adopted by the Tokyo Electric Power Company, Japan & Toshiba Corporation for distribution automation in the Ginza area of Tokyo is relevant. In this project a three step approach was adopted. In the first stage automation by stand-alone pole-mounted equipment with built in facility for communication capability was adopted. Introduction of remote control from a control centre by means of pole top RTUs and distribution line carrier was done in the second stage of the project. It was in

the third stage that the integration of the entire scheme conceived in stages I & II into a central computer based integrated distribution automation scheme for automated centralized control was contemplated. Gujarat could also perhaps adopt this step by step approach in distribution automation by implementing small integrated distribution automation schemes for limited distribution areas tailored to the specific needs and conditions of the areas concerned. Depending upon the experience gained with these small DA schemes, more areas in other areas of the state.

8.10 Recommendations

In view of the extensive spread of the distribution system in the state as well as the size of the state, it would be best to draw up a phased program for switching over to D.A in a cautious manner. To start with introduction of distribution automation could be considered in respect of a few urban areas like Ahmedabad, Baroda, Surat, Rajkot etc., priorities being based mainly on cost-benefit considerations. However, as far as semi-urban and rural areas are concerned, a number of pilot projects could be taken up in all the five zones of the state mainly with the idea of implementing DSM measures and also for improving the quality and reliability of power supply and also for reducing fault attendance and rectification time. These schemes could be modelled on the one presently under implementation in Andhra Pradesh - viz, the Gachibowli project. Suitable 66 kV substations in the various districts of the state could be chosen for setting up District Control Centres (DCC). For each of these DCCs, DA schemes could be implemented with RTUs installed on the outgoing 11 kV feeders for monitoring and controlling the distribution transformers, capacitor banks and load break switches. Wherever applicable, auto-metering facilities could also be provided for by monitoring the electron trivector meters at H.T consumer locations. As regards communication facilities for these projects, in addition to available PLCC facilities, for more dependable service multiple Access Radio System (MARS) operating in 900 MHz frequency range and based on time-division-multiple Access (TDMA) could be employed. MARS could be used for two-way data communication and VHF radio for one way control of agricultural feeders. Other functions that could be implemented are network optimization, integrated volt/VAR control, load management, automatic load shedding, remote metering, energy scheduling and accounting.

The above scheme of DCC at 66 kV s/s with SCADA features on 11 kV and LT feeders could ultimately form a part of in an overall scheme to be developed where a centrally located distribution control centre (CDCC) (located at a suitable 132 kV substation)controls the functioning of a group of outlying District Control Centres (located at 66 kV substations). The CDCC would be linked with the zonal headquarters of the utility for Management

Information Service (MIS) functions on PLCC backed up by a microwave ($2GH_z$ based) link or MARS channel working in TDMS mode. CDCC would also be linked with the outlying DCCs by means of MARS communication channel working in the TDMA mode, which would enable the DCC to communicate with a large number of stations with a single pair of frequencies. A skeleton schematic diagram of a typical DA scheme is given at Figure 2.

It has to be emphasized that selection of a suitable profit centre for automation has to be done very judiciously, as the implementation of subsequent stages of the scheme is dependent on the success of this project. The project chosen should preferably have a good mix of all types of consumers and with good data base. Before opting for automation of a particular profit centre, it would be advisable to carry out a detailed study of the various automation options available, their advantages and disadvantages vis-a-viz the existing system. Finally a cost-benefit analysis of the different alternatives has to be carried out for the selection of the appropriate option.

References

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CHAPTER 9

Supply and demand side management measures for Gujarat

9.1 Introduction

A study of typical load curves of GEB system (Appendix-1) indicate that there is considerable difference between the system demands recorded during the peak and off-peak periods in the daily load cycle in all the three seasons of the year. The ratios of peak to off-peak system loads on typical days in summer, winter and monsoon seasons in indicated in the following table:

Season	**Ratio of peak to off-peak**		
	1992/93	**1993/94**	**1994/95**
Summer	1.42	1.44	1.44
Monsoon	1.43	1.43	1.43
Winter	1.44	1.42	1.45

Source: GEB Load Despatch Centre

This type of daily load curves with a number of peaks and valleys indicate the desirability of adopting suitable demand and supply side (DSM) measures for effecting energy conservation as well as develop appropriate strategies for achieving the objectives of peak clipping, valley filling, etc. which would enable optimal planning of new capacity additions.

9.2 Objectives of load shape analysis

Load shape analysis is a perquisite for conducting any analysis of the cost of supplying power, impact analysis of strategies to change demand patterns or effect energy conservation, and impact of tariff revision. Coupled with costs and reliable load forecasts, system load shapes can be used to determine appropriate load shape to achieve objectives such as peak load reductions, valley filling, strategic load growth, etc. which can be used to optimally plan new capacity requirements.

Sector and end-use level hourly load curves provide additional information on loads imposed by different categories of customers and their contribution to the system load shape. This information is useful for developing suitable strategies for different consumer groups

which can help better design of suitable tariff structures for equitable revenue realization, or decide on incentives/penalties schemes which may help meet load shape objectives. Sector level load shapes are also an indispensable tool in designing DSM programms which target end-uses in the appropriate sector to cost-effectively meet load shape objectives. However for GEB system although hourly load curves for the overall system is available consumer sector-wise hourly load curves have not been developed so far.

9.3 Methodology for identification of potential DSM options

On the basis of the studies regarding the hourly load contributions of each of the consumer categories like domestic, commercial, industrial, agriculture etc. to the overall system daily load curve all appropriate DSM options applicable to each of the consumer categories is to be listed out. Thereafter, screening of the various DSM options for their cost effectiveness as well as practicability of implementation under actual field conditions has to be done. Screening of DSM options would involve the following steps:

i. Identification of potential DSM options
ii. Develop screening criteria
iii. Assign appropriate weightage factor for screening criteria
iv. Work out scoring points of each DSM option
v. Calculate overall weighted rank of each DSM option
vi. Shortlist the options for detailed study.

The screening criteria should cover such factors as the suitability of the DSM option for meeting the load shape objectives (e.g. peak clipping/valley filling, load shifting etc.), technology availability, customer acceptance (financial/non financial), magnitude of savings potential, reliability of performance of the option, GEB revenue collection (dependent on customer category-wise tariff).

A typical screening matrix for DSM options is at Table 1.

Table 1. DSM options screening matrix

	Weightage*		7	3	5	4	5	6	7
Sl. No.			Meets load shape objectives	Product or technology availability	Customer acceptance (Financial)	Customer acceptance (Non-financial)	Magnitude of savings potential	Reliability of technology/ savings	Revenue considerations of utility
	Consumer category	DSM options							
			1	2	3	4	5	6	7
		Domestic and commercial sectors							
1	Dom/Comm	Compact fluorescent lamps							
2	Dom/Comm	Lower wattage fluorescent lamps							
3	Dom/Comm	Rare earth phosphors for fluorescent lamps							
4	Dom/Comm	Electronic ballasts							
5	Dom/Comm	High efficiency luminaries							
6	Dom/Comm	High effc. evaporative coolers							
7	Dom/Comm	High effc. room AC							
8	Dom/Comm	Commercial HVAC effic. Improvements							

*Weightage factors mentioned in the table are only indicative figure.

	Weightage*		7	3	5	4	5	6	7
Sl. No.			Meets load shape objectives	Product or technology availability	Customer acceptance (Financial)	Customer acceptance (Non-financial)	Magnitude of savings potential	Reliability of technology/ savings	Revenue considerations of utility
	Consumer category	DSM options							
			1	2	3	4	5	6	7
11	Dom/Comm	Electronic speed regulators							
12	Dom/Comm	Building automation systems							
13	Dom/Comm	Solar water heating							
14	Dom/Comm	Motor sizing							
		Industrial sector							
15	Ind	Mercury vapor lamps for industrial lighting							
16	Ind	Motor sizing							
17	Ind	Motor rewinding							
18	Ind	High efficiency motors							
19	Ind	Soft start controls for motors							
20	Ind	Variable speed drives							
21	Ind	Efficient fans							
22	Ind	Efficient pumps							
23	Ind	Efficient air compressors							
24	Ind	High effic. refrigeration compressors							

Sl. No.	Consumer category	DSM options	Meets load shape objectives	Product or technology availability	Customer acceptance (Financial)	Customer acceptance (Non-financial)	Magnitude of savings potential	Reliability of technology/ savings	Revenue considerations of utility
Weightage*			7	3	5	4	5	6	7
			1	2	3	4	5	6	7
25	Ind	System improvements-pumps/fans/comp.							
26	Ind	Efficient drive transmission systems							
27	Ind	Efficient electric heating							
28	Ind	Solar water heating							
29	Ind	High power transformers							
30	Ind	Improved electric air furnaces							
31	Ind	Industrial process efficient improvements							
32	Ind	Process Automation systems							
33	Ind	Power factor Improvement							
		Agricultural sector							
34	Ag	Foot valve replacement							
35	Ag	Low friction pipes							
36	Ag	Pumpset sizing							
37	Ag	High efficiency pumpsets							
38	Ag	Power factor improvement							

	Weightage*		7	3	5	4	5	6	7
Sl. No.			Meets load shape objectives	Product or technology availability	Customer acceptance (Financial)	Customer acceptance (Non-financial)	Magnitude of savings potential	Reliability of technology/ savings	Revenue considerations of utility
	Consumer category	DSM options							
			1	2	3	4	5	6	7
39	Ag	Wind pumpsets							
40	Ag	Solar pumpsets							
		Public water works							
41	PWW	Pumpset sizing							
42	PWW	Variable speed drives							
		Street lighting							
43	SL	High pressure sodium lamps							
44	SL	Timers for street lighting							
		General							
45	G	Housekeeping							

Sl. No.	Consumer category	DSM options	Meets load shape objectives	Product or technology availability	Customer acceptance (Financial)	Customer acceptance (Non-financial)	Magnitude of savings potential	Reliability of technology/ savings	Revenue considerations of utility
	Weightage*		7	3	5	4	5	6	7
			1	2	3	4	5	6	7
39	Ag	Wind pumpsets							
40	Ag	Solar pumpsets							
		Public water works							
41	PWW	Pumpset sizing							
42	PWW	Variable speed drives							
		Street lighting							
43	SL	High pressure sodium lamps							
44	SL	Timers for street lighting							
		General							
45	G	Housekeeping							

9.4 DSM options for Gujarat

It is suggested that scientific study for identifying the suitable cost-effective options applicable to the four regions of the state on the lines discussed above should be undertaken which should cover extensive round the year field studies covering the summer, winter and monsoon seasons for the four regions. These studies should cover all the major consumer categories with domestic, commercial, agriculture, L.T & H.T Industry etc. However, the detailed DSM studies of this magnitude to be organized and undertaken by Gujarat authorities are likely to take considerable time. In the meantime some of the DSM options that could be considered for implementation are listed below:

Industrial sector

- Use of high efficiency motors
- Variable speed drives
- Energy efficient lighting
- Time of use tariff

Agricultural sector

- Rostering of power supply hours
- Power factor improvement
- Pumpset sizing
- Foot valve replacement
- Low friction pipes
- High efficiency pumpsets
- Solar pumpsets
- Wind pumpsets

Domestic sector

- Energy efficient lighting (Compact fluorescent lamps
- Electronic ballast
- Electronic regulators
- High efficiency electrical/electronic appliances

Commercial sector

- Lighting (CFLs)
- Electronic ballast
- TOU tariffs
- Electronic regulators

9.5 Role of Gujarat Power Utilities in promoting DSM programs in specific sectors

DSM programs have to be targeted to specific consumer sectors and geographic locations where they are most needed. Customers in all sectors are good candidates for DSM programs, especially in areas of lighting, motors, and motor driven equipment.

9.5.1 Domestic and commercial sectors

The domestic sector and commercial sectors in Gujarat offer good DSM potential, and measures would usually apply to large groups of customers which helps to facilitate the program implementations. Thus DSM programs targeting these sectors would be an excellent way for communicating to the general public that utilities are promoting energy efficiency which also helps to improve their customer image.

A long term approach should be adopted with four different market approaches; a public relations campaign to increase customer awareness, joint promotions with suppliers and retailers, the use of regulation through codes and standards and direct installation of measures by the utility.

Some of the items considered in the program should include compact fluorescent lamps, electronic ballasts, reduced wattage incandescent lamps. high efficiency fans and appliances (refrigerators and air conditioners), hot water energy savings and load shifting, and thermal cold storage load shifting programs.

Lighting audits may be carried out to identify areas which may be overlit and energy savings could be effected, while some other areas may require increased lighting levels limiting the available energy savings.

The program design should take into consideration the needs of the building owners as well as tenants. Often the building owners simply pass on energy costs to the tenants, and the tenants are not usually interested in making additional capital improvements. There are good benefits for both. For building owners new lighting systems offer reduced maintenance and a savings in building operating cost. For the tenants the new lighting system offers higher

quality lighting (light level and colour) and lowers their operating expense.

9.5.2 *Agricultural Sector*

The focus in the agricultural sector should be on irrigation pumping. The high potential of energy savings in this sector makes this one of the most attractive targeted program areas.

In addition to installing efficient pumps and rectifying existing pumps, the irrigation methods should also be reviewed. There may be simple improvements that could be made to the irrigation systems to improve water distribution and reduce evaporation losses. Scheduling the irrigation times may also identify load shifting or peak shaving opportunities.

A well designed irrigation program can benefit both the utility and the customer. Some of the program elements that should be considered include:

- a review of existing irrigation methodology with possible third party financing option to make capital improvements.
- use of high efficiency pumps - cost paid through energy savings, possibly directly financed through the energy bill
- metering of all agricultural pumpsets

9.5.3 *Industrial sector*

The industrial sector in Gujarat offers some interesting challenges to the utility but the returns can be well worth the effort. Results in this sector should largely come from working closely with large high value customers and targeting specific opportunities with the medium sized industry.

Segmentation by technology is often beneficial. For example, motors typically account for about 70% of industrial electricity consumption, of which an estimated 80% is consumed by fan, pump and blower systems. Concentrating on industries that are either growing or retrofiting for competitive reasons would be profitable.

9.5.4 *High Efficiency Motor (HEM) Program*

The incremental cost is usually too high to justify a HEM program designed to replace all operating motors. However, a high efficiency motor program can be cost effective when the customer is purchasing new or replacement motors.

At present high efficiency motors represent a negligible portion of the current sales. With this very low market share it is very likely that financial incentives would be required. A HEM program design should encourage motor manufacturers to produce the motors, the

distributors to stock them and offer a relatively small price differential to encourage customers to buy them. Often customers need placement motors on very short notice and they must be readily available with the local distributors.

9.5.5 *Industrial Process Savings*

An industrial performance optimization program should be considered for energy savings in fans, pumps and blowers which constitute approximately 50-55% of the electricity used by industry. Significant savings can be achieved when these systems are optimized to more accurately meet process demands. This could include retrofit such as replacement with properly sized efficient equipment, the use of variable speed drives and system or process modifications designed to reduce losses.

In order to achieve these savings GEB should develop programs that focus on individual needs of the customers. This is best achieved by carrying out energy audits to identify the areas of savings, a feasibility assistance program to provide a cost benefit analysis for the selected measures, followed by a financial incentive program designed to give the customers a good return on their investment.

9.5.6 *Industrial Load Shifting (Time of use tariff)*

Out of four Electricity Boards viz. GEB, MSEB, TNEB & WBSEB, GEB has the longest experience (more than a decade) with TOU tariff structure. On the basis of their experience over all these years, they have made a number of modifications in regard to the quantum of rebates/concessions, target consumers (initially till May 1987 Agricultural consumers were also covered in the TOU scheme) - but the basic structure of the TOU tariff has remained the same. Discussions with GEB engineers however indicated that the consumers did not find the rebates/concessions offered for off-peak period consumption attractive enough in view of the following reasons:

- Most of the consumers are habitually tuned to working during daytime, and apprehend that night hours working would affect the quality and quantity of production
- There is reluctance on the part of the workers to work at night
- Female workers have to be excluded from the night working team
- It becomes necessary for the owner to arrange for transport for the night shift workers adding to the cost of production.

It is understood that only 15-20% of the HT consumers are availing of the benefits of off-peak concessions/rebates in electricity consumption. During discussions with some of the industrial consumers it was revealed that the general consensus was that they find it more convenient to pay the peak-hour consumption surcharge rather than go through the inconvenience of arranging for night-hour working as they are able to realize the extra cost from their consumers by adding it on to the cost of the product. Thus one is led to conclude that although the TOU tariff has been able to generate extra revenue for the Board through peak-hour consumption surcharge, it has not been able to achieve the objective of shifting loads from peak-hour to off-peak hours.

9.5.7 Impact Evaluation of current GEB TOU tariff

The primary objective of introducing TOU tariff is to induce the customers to shift a part of their consumption from peak-hours to off-peak hours by offering them suitable attractive concessions so as to flatten the daily load curve enabling the utility to make use of its available generating resources in an optimal manner. Judged from this angle, it appears that the current GEB TOU tariff has not been successful in realizing this objective. This observation is based on the following facts:

- General consensus amongst the H T consumers is that the TOU tariff is not attractive enough for them to shift their operations during the night (off-peak) period. Only 15-20% of H T consumers out of a total of 2824 consumers are reported to have opted for availing the off-peak tariff concessions.
- On the basis of discussions with the representatives of the H T industries it appeared that according to their thinking the penal peak hour surcharge levied by GEB can very well be absorbed by them, as the resulting increase in the cost of the final product is passed on to the consumer and it does not affect their sales.
- During the discussions with the GEB engineers on the impact of their TOU tariff on the pattern of their daily load curve, it was stated by them that the extra revenue earned by the Board due to the levy of peak-hour consumption surcharge amounted to Rs 23.96 crores in 1991/92 and Rs 26.26 crores in 1992/93. They however stated that it has not been possible for the board to assess how much load shift has taken place from peak hours to off-peak hours, although they felt that peak hour loading has reduced marginally. It has not been possible for TERI also to make such an analysis for lack of adequate data.

In sum, it appears that GEB TOU tariff as presently structured helps the Board to earn extra revenue by levying a surcharge on peak-hour consumption only, and the off-peak hour rebates offered have not been found attractive enough by the consumers.

9.6 Suggestions for restructuring current TOU tariff

A study of the impact of the TOU tariff of GEB as presently structured reveals that this has been successful in generating extra revenues for the Board due to higher pricing of peak hours electricity consumption. However, it may not have been quite effective in realizing the other objective of shifting loads from peak to off-peak hours. The following suggestions are being made which might be taken into consideration while restructuring the tariff.

- It is important to have knowledge about the customer response to alternative tariff proposals, as this would help in designing an effective TOU tariff to suit GEB load shape and at the same time take into account the requirements of the states industrial consumers.
- GEB could conduct price elasticity studies for different industrial consumer categories. This would help in designing TOU tariffs targeted toward the various types of industries whose requirements differ from each other.
- GEB should use the spread sheet model to study the effect of various possible tariff scenarios on different consumer segments. This would help in developing optimal tariff structure.
- As regards TOU metering, GEB could continue to use mechanical time switched poly phase meters for low value customers.
- For high value customers, more sophisticated hybrid type of meters could be introduced.

9.7 Organisation structure for DSM

It would be advisable for GEB to set up a DSM cell headed by an Officer at the level of Chief Engineer, The DSM cell could have full time staff, strength and composition of which would depend upon the magnitude and size of the DSM program proposed to be undertaken. To start with small groups could be set up in the following ones:

- Market research, planning and program evaluation
- Program design and implementation
- Industrial sector

- Agricultural sector
- Commercial sector
- Domestic sector

References

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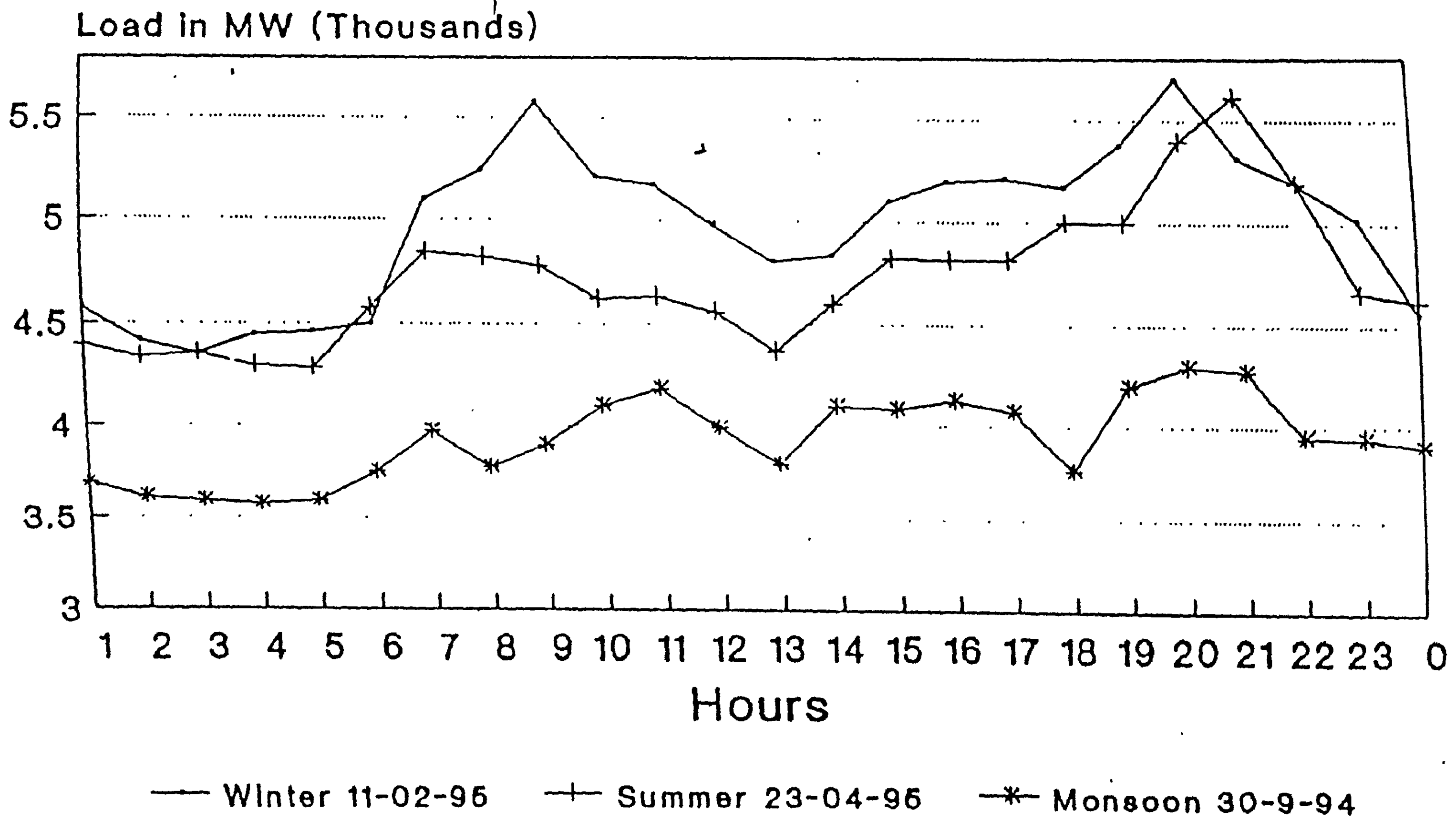
3. "Competitive electricity markets in practice : experience from Norway" - the Electricity Journal (June 1994).

Appendix -1 Daily load curves
Winter, Summer and Monsoon seasons.



Source : LDC, Jambva

CHAPTER 10

Fund requirements for need-based power plan for Gujarat (utility sector) in 9th, 10th & 11th plan periods and possible mode of funding and investment pattern

10.1 The power expansion plan for Gujarat in the 9th, 10th and 11th plan periods as discussed in the earlier chapters is based on the actual requirements of additional generation capacities needed for meeting anticipated load demands during these periods. In other words the power expansion program drawn up is basically a need-based plan and in order to translate the blue-print into actual working model, required financial resources have to be found. This aspect is particularly relevant in the Indian context due to limited resources availability for the purpose as well as the capital intensive nature of the power generation plants and associated equipment. It is in this context that an exercise has been carried out to make a rough assessment of the resource requirements for implementing the rather massive power expansion program as outlined in the earlier chapters that Gujarat would have to take up in the coming years to meet the ever-increasing load demands of the state.

10.2 Fund requirements for need-based power plans in 9th, 10th & 11th plan periods

As discussed earlier, the need-based capacity expansion program as assessed in the present studies is as follows:

	MW
9th plan (1997-2002)	5020
10th plan (2002-007)	6764
11th plan (2007-012)	8250

The fund requirements for implementing the above program comprising coal/lignite-based and gas/naphtha based thermal stations, have been worked out assuming representative average costs of Rs.4.26 crores per MW and Rs.3.41 crores per MW respectively. A representative figure of Rs.2.77 crores/MW for heavy oil based thermal and Rs.4.5 crores/MW for hydel generation has been assumed. All these figure are at 1994-95 level of prices.

As far as the fund requirements for associated transmission and distribution works are

concerned, the estimates are based on a normative requirement of Rs.2.84 crores/MW (i.e. about 67% of outlay on generation). The total investment on T&D has been further broken up into funds for E.H.T transmission (132 kV and above), sub-transmission (66 kV, 33kV and 22 kV) and distribution (11 kV & below) approximately in the ratio of 37.5 12.5:50. These normative figures for outlays on T&D corresponding to the outlay on generation are indicative in nature and are by and large based on the trends on the pattern of funding on various projects in different parts of the country which are received in CEA for their clearance.

On the basis of the above assumptions, the fund requirements for the 9th, 10th and 11th plans work out as follows:

Table 1. Fund (Investment) requirements for need based plan (Rs.crores)

Item	9th plan	10th plan	11th plan
Generation	16210	16310	28524
Transmission	5607	7193	8786
Sub-transmission	1869	2398	2929
Distribution	7476	9591	11715
Total investment	31163	35812	51954

Details of the calculations covering the estimates for fund requirements for the power sector (utilities only) of the state during 9th, 10th and 11th plan periods are at Annexure-10.1.

10.3 Funding pattern of power sector (utilities only) in 9th, 10th and 11th plans

Presently Gujarat like all other states in India is facing acute resource constraints for financing all the sectors in their economy. Although allocations for the power sector have been comparatively reasonable in view of its importance in development of other key allied sectors like industry, agriculture etc., these allocations have normally fallen short of the requirements. The position has further worsened to such an extent that the government resources are hardly adequate to meet the aspirations of the important sub-sectors of the states economy. It is in this context that it is felt that full advantage should be taken of the present liberalization policy of the government in so far as the induction of private entrepreneurs in the power sector of the country is concerned. With the privatization of the power sector and the ongoing restructuring of the SEBs, a large chunk of generation projects could be taken up for execution by the Independent Power Producers (IPPs). Under this scenario the function of the utility will mainly be limited to the role of a promoter of the project with a small equity participation which could be anything between 3 to 10% of the cost of the project. Part of promoters equity contribution could be funded by public sector undertakings and or by public

contributions.

As per the current plans of the Gujarat government, it is understood that in the 9th plan the state government is likely to make available funds to the extent of Rs:5,500 crores only in the energy sector which would hardly be adequate to support the need-based requirement of capacity addition program assessed by TERI comprising addition of 5020 MW for the implementation of which the fund requirement is estimated to be about Rs.31163 crores for the generation and associated T&D program. In order to realise the target of 5020 MW addition in generation capacity in 9th plan and taking into consideration the resource constraints and at the same time keeping in view the liberalized policy of the government for private sector entry in power, a probable funding pattern which could be profitably considered has been drawn up - vide Annexure 10.2. The salient points regarding the assumptions that have gone into drawing up this financial plan is briefly discussed below.

It has been assumed that in so far as generation is concerned the role of the public sector power utilities would be limited and bulk of the generation program would be in the private sector. It has been suggested that for the three plan periods which are under consideration, the funding would by and large follow the pattern indicated below:

Generation Investment	
Utility outlay	3%
IPP's outlay	97%
Transmission	
Utility outlay	20%
IPP's outlay	80%
Sub-transmission	
Utility outlay	70%
IPP's outlay	30%
Distribution	
Utility outlay	50%
IPP's outlay	50%

The assumptions regarding private sector participation in the T&D works is based on the following likely scenario.

The EHT/HT transmission associated with the projects for evacuation of power from IPP generation projects would form part of the IPP's generation project itself. Apart from this, private entrepreneurs might be interested in taking up EHT transmission projects involving augmenting/strengthening the Gujarat grid network for improving the reliability of

transmission system. The sub-transmission system requirements corresponding to the additional generation inducted into the system will have to be funded mainly by SEB except for the transmission lines associated with evacuation from generating stations. It is visualized that in the initial stages of privatization the augmentation and strengthening of the distribution network will have to be carried out mainly by SEBs. In course of time, 'distribution' might be leased/rented to private licensees who would be allowed to sell power to the consumer at mutually agreed rates.

10.4 Resource plan for financing utility sector in 9th,10th & 11th plans

The existing capital structure of most of the SEBs in the country is made up of 95% loans (64% government loans, 15% institutional loans and 16% markets borrowing) and only 5% internal resources. Corresponding to this the loan equity ratio works out to about 19:1 which indicates a very unsound financial position of the SEBs as they have no financial control over their business and are entirely dependent on outside agencies for their existence. For healthy functioning, the desirable capital structure of the SEBs as per normative standard should be made up of not more than 75% to 80% loan capital and balance 25% to 20% internal resources. On this basis, the debit-equity ratio works out to 4:1/3:1 which incidentally is also the ratio recommended by some of the inter-national financing organizations.

For working out the resource plan for utility sector in Gujarat in the present exercise a debt-equity ratio of 75:25 has been assumed. As far as the debt component is concerned, it has been assumed that 40% of the loan would be made available by the state government from central plan assistance 20% from financial institutions and the balance 15% from market borrowing. On the equity side it has been assumed that out of the required 25%, 20% equity holding would be of the utility financed from its own internal resources and the balance 5% to be held by other public sector undertakings. However for raising the 20% internal resources, it would be necessary to revise the tariff structure in such a manner so as to earn a surplus to the required extent. For this purpose, the 3% surplus stipulated in the existing provisions of IE Act has to be suitably raised to at least 7% as recommended by 9th and 10th finance commissions.

Annexure 10.1 Total fund requirement for need-based power plan for Gujarat (utilities only) in 9th, 10th and 11th plans

Item	9th Plan	10th Plan	11th Plan
Generation cost	16210	16631	28524
Transmission cost (132 kV & above)	5607	7193	8786
Sub-Transmission cost (22/33/66 kV)	1869	2397	2929
Distribution cost (11 kV & below)	7476	9590	11715
Total investment on power	**31162**	**35812**	**51954**
Assumptions (For Generation Costs):			
		Rs. Crore/MW	
Coal/Lignite		4.26	
Gas/Naphtha		3.408	
Heavy Oil		2.769	
Hydro		4.5	
Assumptions for Transmission & Distribution Cost			
(Rs Crores/MW)			
Total T&D cost/MW as (Gen: T&D 60:40) 66.67% of generation cost/MW) - Rs. Crores MW	2.84		
Allocated among the three in the following percentage			
Transmission cost (132 kV and above) Rs. Crores/MW	37.5%	**1.065**	
Sub-transmission cost (22/33/66 kV) Rs/MW	12.5%	**0.355**	
Distribution cost (11 kV and below) Rs. Crores/MW	50%	**1.42**	

Annex 10.2. Probable funding pattern of power sector (utilities only) in Gujarat in 9th, 10th & 11th plans: utility outlay vis-a-vis I.P.P outlay

Rupees crores

ITEM	9th Plan	10th Plan	11th Plan
Utility outlay			
Generation	486	499	856
Transmission (132 kV and above)	1121	1438	1757
Sub-tran (22/33/66 kV)	1308	1678	2050
Distribution* (11 kV and below)	3738	4795	5857
Total Utility Outlay	6653	8411	10520
IPP Outlay			
Generation	15724	16132	27668
Transmission cost	4486	5754	7029
Sub-transmission cost	561	720	879
Distribution cost	3738	4795	5858
Total IPP Outlay	24509	27401	41434
Total power outlay	31162	35812	51954

Note The above are based on following assumptions:

	Utility investment	IPP investment
Generation	3%	97%
Transmission (132 kV & above)	20%	80%
Sub-transmission (22/33/66 kV)	70%	30%
Distribution* (11 kV and below)	50%	50%

* includes rural electrification

nnexure 10.3 Resource plan (utility) sectors:9th,10th& 11th plans

Rupees in crores

	9th Plan	10th Plan	11th Plan
Total outlay	**6654**	**8411**	**10520**
State loan	2662	3364	4208
Financial institutions	1331	1682	2104
Mkt Borrow	998	1262	1578
Total Debt	**4991**	**6308**	**7890**
SEB	1331	1682	2104
Public sector undertakings	332	421	526
Total Equity	**1663**	**2103**	**2630**

Assumptions:	
Debt to equity ratio	75:25
State loan	40%
Financial institutions	20%
Market borrowing	15%
Total debt	75%
State Electricity Board	20%
Public sector undertakings	5%
Total equity	25%

Annexure 2.1 Comparison of anticipated energy required and peak load for Gujarat with 15th electric power survey

Year	Energy requirement (mkwh)		Peak load (MW)	
	As per 15 Eps	As per TERI	As per 15 EPS	As per TERI
1996-97	36,099	39,523	5,972	6,355
2001-02	48,777	59,224	8,070	9,522
2006-07	64,356	86,286	10,647	13,873
2011-12	84,111	11,8473	13,913	19,048

Appendix Z

SYSTEM STUDIES OF GUJARAT

SYSTEM CARRIED OUT

BY

GUJARAT ELECTRICITY BOARD

	1997-98	
9FYPP.xls		
	The Projects Considered are :	
1	Gandhinagar -5	210 MW
2	Kadana Stage-II	120 MW
3	GIPCL Extension	160 MW
4	Gandhar CCPP (GTEC)	414 MW
5	Sardar Sarovar Project (Share)	40 MW
6	AEC's Coal Based 'C' Station	60 MW

1997-98

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-------------------------   .  ....  ..  ----------------------
Date and Time : Fri Oct 17 17:21:15 1997
---------------------------------------------------------------   -----
RESULTS OF LOAD FLOW ANALYSIS :
Contingency : BASE CASE
Schedule .  : SCHEDULE 0

-----------------------------------------------------------------   ------
LARGEST BUS NUMBER USED          :  530    ACTUAL NUMBER OF BUSES          :  130
NUMBER OF 2 WIND. TRANSFORMERS :   38    NUMBER OF 3 WIND. TRANSFORMERS :    0
NUMBER OF TRANSMISSION LINES     :  145
NUMBER OF SERIES REACTORS        :    0    NUMBER OF SERIES CAPACITORS     :    0
NUMBER OF CIRCUIT BREAKERS       :    0
NUMBER OF SHUNT REACTORS         :    0    NUMBER OF SHUNT CAPACITORS      :    0
NUMBER OF SHUNT IMPEDANCES       :    0
NUMBER OF GENERATORS             :   19    NUMBER OF LOADS                 :   75
NUMBER OF LOAD CHARACTERISTICS :    0    NUMBER OF UNDER FREQUENCY RELAY:    0
NUMBER OF GEN CAPABILITY CURVES:    0    NUMBER OF FILTERS               :    0
NUMBER OF TIE LINE SCHEDULES     :    0
NUMBER OF CONVERTORS             :    0    NUMBER OF DC LINKS              :    0

--------------------------------------------------------------------------
ONLY LOAD FLOW - OPTION                               :    0
NUMBER OF ZONES                                       :    5
PRINT OPTION                                          :    5 - BUS WISE FLOW PRINT
PLOT OPTION                                           :    1 - PLOTTING WITH PU VOLTAG
NO FREQUENCY DEPENDENT LOAD FLOW, CONTROL OPTION:    0
BASE MVA                                              : 100.000000
NOMINAL SYSTEM FREQUENCY (Hzs)                        : 50.000000
FREQUENCY DEVIATION (Hzs)                             : 0.000000
FLOWS IN MW AND MVAR, OPTION                          : 0
SLACK BUS                                             :    4
TRANSFORMER TAP CONTROL OPTION                        :    0
Q CHECKING LIMIT  (ENABLED)                           :    4
REAL POWER TOLERANCE (PU)                             :  0.00100
REACTIVE POWER TOLERANCE (PU)                         :  0.00100
MAXIMUM NUMBER OF ITERATIONS                          :   15
BUS VOLTAGE BELOW WHICH LOAD MODEL IS CHANGED         :  0.75000
CIRCUIT BREAKER RESISTANCE   (PU)                     :  0.00000
CIRCUIT BREAKER REACTANCE    (PU)                     :  0.00010
TRANSFORMER R/X RATIO                                 :  0.05000
-------------------------------------------------------------------------
ANNUAL PERCENTAGE INTEREST CHARGES                    :  15.000
ANNUAL PERCENT OPERATION & MAINTENANCE CHARGES        :   3.000
LIFE OF EQUIPMENT IN YEARS                            :  20.000
ENERGY UNIT CHARGE (KWHOUR) IN RUPEES                 :   0.650
LOSS LOAD FACTOR                                      :   0.300
COST PER MVAR IN LAKHS OF RUPEES                      :   3.000
---------------------------------------------------------------------------
ZONE WISE MULTIPLICATION FACTORS
ZONE   P LOAD   Q LOAD    P GEN    Q GEN SH REACT   SH CAP
---  -------- -------- -------- -------- -------- --------
  0     0.000    0.000    0.000    0.000    0.000    0.000
  2     1.000    1.000    1.000    1.000    1.000    1.000
  4     1.000    1.000    1.000    1.000    1.000    1.000
  1     1.000    1.000    1.000    1.000    1.000    1.000
  3     1.000    1.000    1.000    1.000    1.000    1.000
  5     1.000    1.000    1.000    1.000    1.000    1.000
    ... ---------------------------------------  ...   ---------------
[illegible] DATA
```

```
BUS NO. STATUS ZONE   BUS KV  VMIN-PU  VMAX-PU     NAME
---- ------ ----  -------- -------- -------   --------
     1      1    2  132.000    0.950    1.050 DHUVARAG
     2      1    4  132.000    0.950    1.050   SIKKAG
     3      1    1  220.000    0.950    1.050 UKAIHYDG
     4      1    1  220.000    0.950    1.050 UKAITHEG
     5      1    2  220.000    0.950    1.050 WANAKBIG
     6      1    2  400.000    0.950    1.050 WANAKBEG
     7      1    3  220.000    0.950    1.050 GANDHING
     8      1    5  220.000    0.950    1.050 PANANDRG
     9      1    2  220.000    0.950    1.050  KADANAG
    10      1    1  220.000    0.950    1.050  JHANORG
    11      1    3  132.000    0.950    1.050 AECOMPDG
    12      1    2  400.000    0.950    1.050  INDORE4
    13      1    2  132.000    0.950    1.050   GIPCLG
    14      1    1  220.000    0.950    1.050  UTRANEG
    15      1    1  220.000    0.950    1.050   KAWASG
    16      1    1  220.000    0.950    1.050 KAKRAPAG
    17      1    1  220.000    0.950    1.050   ESSARG
    18      1    1  220.000    0.950    1.050  GTEC-IG
    19      1    2  400.000    0.950    1.050     SSP4
    51      1    2  400.000    0.950    1.050    ASOJ4
    52      1    2  400.000    0.950    1.050 WANAKBO4
    53      1    4  400.000    0.950    1.050  JETPUR4
    54      1    1  400.000    0.950    1.050 UKAITHE4
    55      1    3  400.000    0.950    1.050    SOJA4
    56      1    2  400.000    0.950    1.050   KASOR4
    57      1    4  400.000    0.950    1.050 CHORANI4
    58      1    1  400.000    0.950    1.050  JHANOR4
    59      1    2  400.000    0.950    1.050  DEHGAM4
    60      1    3  400.000    0.950    1.050   ZERDA4
    61      1    1  400.000    0.950    1.050    GTEC4
   101      1    1  220.000    0.950    1.050   NASIK2
   103      1    2  220.000    0.950    1.050 WAGODIA2
   104      1    4  220.000    0.950    1.050 SARDGAD2
   105      1    1  220.000    0.950    1.050 TARAPUR2
   106      1    1  220.000    0.950    1.050 NAVSARI2
   107      1    1  220.000    0.950    1.050    VAPI2
   108      1    1  220.000    0.950    1.050 VALTHAN2
   109      1    1  220.000    0.950    1.050 UKAITHE2
   110      1    1  220.000    0.950    1.050 UKAIHYD2
   111      1    1  220.000    0.950    1.050 ACHHALI2
   112      1    2  220.000    0.950    1.050 JAMBUVA2
   113      1    2  220.000    0.950    1.050    ASOJ2
   114      1    2  220.000    0.950    1.050 CHANDRA2
   115      1    2  220.000    0.950    1.050  GODHRA2
   116      1    2  220.000    0.950    1.050 WANAKBO2
   117      1    2  220.000    0.950    1.050  KADANA2
   118      1    3  220.000    0.950    1.050 DHANSUR2
   119      1    3  220.000    0.950    1.050 RANASAN2
   120      1    2  220.000    0.950    1.050 KARAMSA2
   121      1    4  220.000    0.950    1.050   LIMDI2
   122      1    4  220.000    0.950    1.050  VARTEJ2
   123      1    4  220.000    0.950    1.050  GONDAL2
   124      1    4  220.000    0.950    1.050  JETPUR2
   125      1    4  220.000    0.950    1.050  KESHOD2
   126      1    4  220.000    0.950    1.050 KODINAR2
   127      1    4  220.000    0.950    1.050 SAVARKU2
   128      1    3  220.000    0.950    1.050 VIRAMGA2
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129      1    3  220.000    0.950    1.050 CHHATRA2
130      1    3  220.000    0.950    1.050 GANDHIN2
131      1    3  220.000    0.950    1.050    SOJA2
132      1    3  220.000    0.950    1.050 MEHSANA2
133      1    3  220.000    0.950    1.050  DEODAR2
134      1    5  220.000    0.950    1.050   ANJAR2
135      1    5  220.000    0.950    1.050 PANANDR2
136      1    3  220.000    0.950    1.050 PALANPU2
137      1    3  220.000    0.950    1.050 VIJAPUR2
138      1    4  220.000    0.950    1.050 RANAVAV2
139      1    3  220.000    0.950    1.050 HIMATNA2
140      1    4  220.000    0.950    1.050 DHRANGA2
141      1    1  220.000    0.950    1.050 HALDARV2
142      1    1  220.000    0.950    1.050 ICHHAPU2
143      1    3  220.000    0.950    1.050   ZERDA2
144      1    1  220.000    0.950    1.050     KIM2
145      1    2  220.000    0.950    1.050 KAPADWA2
146      1    1  220.000    0.950    1.050   UTRAN2
147      1    1  220.000    0.950    1.050   KAWAS2
148      1    1  220.000    0.950    1.050 KAKRAPA2
149      1    5  220.000    0.950    1.050 NAKHATR2
150      1    5  220.000    0.950    1.050 NANIKHA2
151      1    4  220.000    0.950    1.050 VISAVAD2
152      1    4  220.000    0.950    1.050 MOTIPAN2
153      1    4  220.000    0.950    1.050 DHOKADV2
154      1    1  220.000    0.950    1.050   ESSAR2
155      1    1  220.000    0.950    1.050  JHANOR2
156      1    1  220.000    0.950    1.050 ZAGADIA2
157      1    2  220.000    0.950    1.050 SALEJAD2
158      1    3  220.000    0.950    1.050 SANKHAR2
159      1    3  220.000    0.950    1.050   JAMLA2
160      1    3  220.000    0.950    1.050 KHERALU2
161      1    4  220.000    0.950    1.050   MORVI2
163      1    4  220.000    0.950    1.050  RAJKOT2
165      1    4  220.000    0.950    1.050 JAMNAGA2
166      1    2  220.000    0.950    1.050  DEHGAM2
167      1    2  220.000    0.950    1.050 KHANPUR2
168      1    4  220.000    0.950    1.050 CHORANI2
169      1    2  220.000    0.950    1.050   KASOR2
170      1    1  220.000    0.950    1.050 CHIKHLI2
171      1    3  220.000    0.950    1.050  THARAD2
172      1    1  220.000    0.950    1.050   WAGRA2
173      1    1  220.000    0.950    1.050    GTEC2
501      1    2  132.000    0.950    1.050 DHUVARA1
502      1    2  132.000    0.950    1.050 KARAMSA1
503      1    2  132.000    0.950    1.050   VATWA1
504      1    3  132.000    0.950    1.050 RANASAN1
505      1    3  132.000    0.950    1.050 SABARMA1
506      1    5  132.000    0.950    1.050   ANJAR1
507      1    4  132.000    0.950    1.050 WANKANE1
508      1    4  132.000    0.950    1.050 NAGHEDI1
509      1    4  132.000    0.950    1.050   SIKKA1
510      1    4  132.000    0.950    1.050   LIMDI1
511      1    4  132.000    0.950    1.050 DHANDHU1
512      1    4  132.000    0.950    1.050  PALIAD1
513      1    4  132.000    0.950    1.050  GONDAL1
514      1    4  132.000    0.950    1.050  RAJKOT1
515      1    4  132.000    0.950    1.050 RANAVAV1
516      1    4  132.000    0.950    1.050  BHATIA1
517      1    3  132.000    0.950    1.050  AECOMP1
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  1     2   132.000      0.950     1.050   GOTRI1
  1     2   132.000      0.950     1.050 JAMBUVA1
  1     2   132.000      0.950     1.050 FERTNGR1
  1     2   132.000      0.950     1.050    ASOJ1
  1     2   132.000      0.950     1.050 NANDESA1
  1     2   132.000      0.950     1.050 JAWAHAR1
  1     2   132.000      0.950     1.050 MIYAGAM1
  1     1   132.000      0.950     1.050 BHARUCH1
  1     1   132.000      0.950     1.050 ANKLESH1
  1     1   132.000      0.950     1.050 ACHHALI1
  1     2   132.000      0.950     1.050   GIPCL1
  1     4   132.000      0.950     1.050 JAMNAGA1
  1     4   132.000      0.950     1.050 JAMKHAM1
---------------------------------------------------------------------
R DATA

FROM FROM          TO TO                 IMPEDANCE           NOMINAL    RATING
NODE NAME*       NODE NAME*          R(P.U)     X(P.U.)         TAP        MVA
                                     MINTAP      MAXTAP      TAPSTEP  SHIFT-DE
---- -------- ---- -------- --------- --------- --------- --------
 501 DHUVARA1    1 DHUVARAG   0.00088   0.01768   1.05000   710.00
                              0.95000   1.05000   0.02500    0.000
 509    SIKKA1   2    SIKKAG  0.00210   0.04205   1.05000   300.00
                              0.95000   1.05000   0.02500    0.000
 110 UKAIHYD2    3 UKAIHYDG   0.00157   0.03146   1.04100   340.00
                              0.95000   1.05000   0.02500    0.000
 109 UKAITHE2    4 UKAITHEG   0.00067   0.01338   1.03600  1010.00
                              0.95000   1.05000   0.02500    0.000
  54 UKAITHE4  109 UKAITHE2   0.00183   0.03665   0.95000   315.00
                              0.95000   1.05000   0.02500    0.000
 116 WANAKBO2    5 WANAKBIG   0.00097   0.01938   1.04500   750.00
                              0.95000   1.05000   0.02500    0.000
  52 WANAKBO4    6 WANAKBEG   0.00097   0.01938   1.05000   750.00
                              0.95000   1.05000   0.02500    0.000
  52 WANAKBO4  116 WANAKBO2   0.00212   0.04245   0.95000   315.00
                              0.95000   1.05000   0.02500    0.000
 130 GANDHIN2    7 GANDHING   0.00063   0.01268   1.03600  1030.00
                              0.95000   1.05000   0.02500    0.000
 135 PANANDR2    8 PANANDRG   0.00214   0.04275   1.04500   300.00
                              0.95000   1.05000   0.02500    0.000
 117   KADANA2   9   KADANAG  0.00218   0.04365   1.04100   300.00
                              0.95000   1.05000   0.02500    0.000
 517   AECOMP1  11 AECOMPDG   0.00122   0.02447   1.04500   555.00
                              0.95000   1.05000   0.02500    0.000
 528    GIPCL1  13    GIPCLG  0.00187   0.03745   1.04500   400.00
                              0.95000   1.05000   0.02500    0.000
  51     ASOJ4 113     ASOJ2  0.00061   0.01218   0.95000  1000.00
                              0.95000   1.05000   0.02500    0.000
 113     ASOJ2 521     ASOJ1  0.00157   0.03146   0.97500   300.00
                              0.95000   1.05000   0.02500    0.000
  53   JETPUR4 124   JETPUR2  0.00061   0.01218   0.95000   945.00
                              0.95000   1.05000   0.02500    0.000
  55     SOJA4 131     SOJA2  0.00063   0.01258   0.95000  1000.00
                              0.95000   1.05000   0.02500    0.000
 111 ACHHALI2  527 ACHHALI1   0.00164   0.03276   0.97500   300.00
                              0.95000   1.05000   0.02500    0.000
 112 JAMBUVA2  519 JAMBUVA1   0.00246   0.04914   0.97500   200.00
                              0.95000   1.05000   0.02500    0.000
 119 RANASAN2  504 RANASAN1   0.00088   0.01768   0.97500   550.00
                              0.95000   1.05000   0.02500    0.000
```

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 3   1  120 KARAMSA2  502 KARAMSA1   0.00249    0.04984    0.97500    200.00
  120                                0.95000    1.05000    0.02500     0.000
 3   1  121    LIMDI2  510    LIMDI1  0.00211    0.04215    0.97500    200.00
  121                                0.95000    1.05000    0.02500     0.000
 3   1  123   GONDAL2  513   GONDAL1  0.00246    0.04914    0.97500    200.00
  123                                0.95000    1.05000    0.02500     0.000
 3   1  134    ANJAR2  506    ANJAR1  0.00216    0.04325    0.97500    200.00
  134                                0.95000    1.05000    0.02500     0.000
 3   1  138 RANAVAV2  515 RANAVAV1   0.00246    0.04914    0.97500    200.00
  138                                0.95000    1.05000    0.02500     0.000
 3   1   57 CHORANI4  168 CHORANI2   0.00126    0.02517    0.95000    500.00
   57                                0.95000    1.05000    0.02500     0.000
 3   1   58   JHANOR4  155   JHANOR2  0.00063    0.01258    0.95000   1000.00
   58                                0.95000    1.05000    0.02500     0.000
 3   1   56    KASOR4  169    KASOR2  0.00092    0.01838    0.95000    630.00
   56                                0.95000    1.05000    0.02500     0.000
 3   1   59   DEHGAM4  166   DEHGAM2  0.00092    0.01838    0.95000    630.00
   59                                0.95000    1.05000    0.02500     0.000
 3   1  146    UTRAN2   14   UTRANEG  0.00312    0.06242    1.04100    200.00
  146                                0.95000    1.05000    0.02500     0.000
 3   1  147    KAWAS2   15    KAWASG  0.00089    0.01778    1.04100    740.00
  147                                0.95000    1.05000    0.02500     0.000
 3   1  148 KAKRAPA2   16 KAKRAPAG   0.00115    0.02307    1.04100    520.00
  148                                0.95000    1.05000    0.02500     0.000
 3   1  155   JHANOR2   10   JHANORG  0.00088    0.01768    1.04100    750.00
  155                                0.95000    1.05000    0.02500     0.000
 3   1  154    ESSAR2   17    ESSARG  0.00082    0.01648    1.04500    730.00
  154                                0.95000    1.05000    0.02500     0.000
 3   1  165 JAMNAGA2  529 JAMNAGA1   0.00491    0.09828    0.97500    100.00
  165                                0.95000    1.05000    0.02500     0.000
 3   1   60    ZERDA4  143    ZERDA2  0.00099    0.01978    1.04100    630.00
   60                                0.95000    1.05000    0.02500     0.000
 3   1   18   GTEC-IG  173     GTEC2  0.00084    0.01678    1.04500    843.00
  173                                0.95000    1.05000    0.02500     0.000
 3   1  173     GTEC2   61     GTEC4  0.00125    0.02497    0.97500    500.00
   61                                0.95000    1.05000    0.02500     0.000

-----------------------------------------------------------------------------
TRANSMISSION LINE DATA

STA CKT FROM FROM        TO TO                 LINE PARAMETER          RATING    KMS
        NODE NAME*     NODE NAME*         R(P.U)   X(P.U.) B/2(P.U.)    MVA
    --- ---- -------- ---- -------- --------- --------- --------- ------ -----
  3   1   54 UKAITHE4   51     ASOJ4   0.00260   0.02860   0.38200    824   1.0
  3   1   51    ASOJ4   53   JETPUR4   0.00580   0.06430   0.86060    824   1.0
  3   1   52 WANAKBO4   51     ASOJ4   0.00140   0.01540   0.20540    824   1.0
  3   2   52 WANAKBO4   55     SOJA4   0.00090   0.01000   0.53860   1648   1.0
  3   1   51    ASOJ4   57 CHORANI4   0.00310   0.03400   0.45530    824   1.0
  3   1   56    KASOR4   57 CHORANI4   0.00190   0.02080   0.27760    824   1.0
  3   1   57 CHORANI4   53   JETPUR4   0.00300   0.03320   0.44420    824   1.0
  3   2   58   JHANOR4   59   DEHGAM4   0.00210   0.02330   1.24920   1648   1.0
  3   1   51    ASOJ4   56    KASOR4   0.00120   0.01350   0.18040    824   1.0
  3   2   12   INDORE4   51     ASOJ4   0.00270   0.03010   1.61000   1648   1.0
  3   1  105 TARAPUR2  106 NAVSARI2   0.02480   0.12470   0.10080    208   1.0
  3   1  105 TARAPUR2  107     VAPI2   0.01320   0.06650   0.05380    208   1.0
  3   2  101    NASIK2  106 NAVSARI2   0.01330   0.07050   0.24320    416   1.0
  3   2  106 NAVSARI2  108 VALTHAN2   0.00265   0.01330   0.04300    416   1.0
  3   2  109 UKAITHE2  108 VALTHAN2   0.00510   0.02580   0.08320    416   1.0
  3   3  109 UKAITHE2  111 ACHHALI2   0.00430   0.02290   0.17700    624   1.0
  3   2  109 UKAITHE2  110 UKAIHYD2   0.00050   0.00250   0.00840    416   1.0
```

2	148	KAKRAPA2	108	VALTHAN2	0.00350	0.01750	0.05640	416	1.0
2	148	KAKRAPA2	141	HALDARV2	0.00600	0.03030	0.09820	416	1.0
2	148	KAKRAPA2	107	VAPI2	0.00980	0.04900	0.15860	416	1.0
2	110	UKAIHYD2	111	ACHHALI2	0.00640	0.03420	0.11820	416	1.0
2	146	UTRAN2	144	KIM2	0.00200	0.01010	0.03280	416	1.0
2	147	KAWAS2	106	NAVSARI2	0.00380	0.01910	0.06180	416	1.0
1	147	KAWAS2	108	VALTHAN2	0.00600	0.03000	0.02420	208	1.0
2	147	KAWAS2	141	HALDARV2	0.00670	0.03370	0.10880	416	1.0
1	147	KAWAS2	142	ICHHAPU2	0.00140	0.00660	0.00540	208	1.0
1	108	VALTHAN2	144	KIM2	0.00350	0.01750	0.01410	208	1.0
1	144	KIM2	156	ZAGADIA2	0.00350	0.01750	0.01410	208	1.0
1	156	ZAGADIA2	141	HALDARV2	0.00680	0.03410	0.02760	208	1.0
1	141	HALDARV2	112	JAMBUVA2	0.01270	0.06400	0.05170	208	1.0
1	108	VALTHAN2	112	JAMBUVA2	0.01920	0.09640	0.07800	208	1.0
4	111	ACHHALI2	112	JAMBUVA2	0.00180	0.00970	0.13360	832	1.0
1	112	JAMBUVA2	113	ASOJ2	0.00370	0.01980	0.01710	208	1.0
1	112	JAMBUVA2	103	WAGODIA2	0.00410	0.02170	0.01870	208	1.0
1	103	WAGODIA2	113	ASOJ2	0.00500	0.02640	0.02280	208	1.0
2	112	JAMBUVA2	120	KARAMSA2	0.00410	0.02080	0.06720	416	1.0
2	113	ASOJ2	120	KARAMSA2	0.00340	0.01810	0.06260	416	1.0
2	116	WANAKBO2	113	ASOJ2	0.00650	0.03240	0.10480	416	1.0
1	116	WANAKBO2	115	GODHRA2	0.00580	0.02910	0.02350	208	1.0
2	116	WANAKBO2	118	DHANSUR2	0.00500	0.02490	0.08060	416	1.0
1	116	WANAKBO2	119	RANASAN2	0.01290	0.06480	0.05240	208	1.0
1	116	WANAKBO2	145	KAPADWA2	0.00630	0.03160	0.02550	208	1.0
1	145	KAPADWA2	119	RANASAN2	0.00850	0.04280	0.03460	208	1.0
2	117	KADANA2	115	GODHRA2	0.00660	0.03320	0.10760	416	1.0
2	115	GODHRA2	114	CHANDRA2	0.00270	0.01440	0.04980	416	1.0
2	114	CHANDRA2	113	ASOJ2	0.00250	0.01320	0.04560	416	1.0
2	117	KADANA2	118	DHANSUR2	0.00620	0.03120	0.10080	416	1.0
1	118	DHANSUR2	139	HIMATNA2	0.00550	0.02740	0.02220	208	1.0
2	120	KARAMSA2	119	RANASAN2	0.00540	0.02880	0.09960	416	1.0
2	130	GANDHIN2	119	RANASAN2	0.00160	0.00820	0.02860	416	1.0
2	130	GANDHIN2	131	SOJA2	0.00130	0.00660	0.02160	416	1.0
2	130	GANDHIN2	129	CHHATRA2	0.00220	0.01150	0.03980	416	1.0
1	131	SOJA2	136	PALANPU2	0.01570	0.07890	0.06380	208	1.0
1	131	SOJA2	160	KHERALU2	0.01120	0.05650	0.04570	208	1.0
1	160	KHERALU2	136	PALANPU2	0.00840	0.04240	0.03430	208	1.0
2	136	PALANPU2	143	ZERDA2	0.00330	0.01660	0.05380	416	1.0
2	131	SOJA2	137	VIJAPUR2	0.00200	0.01000	0.03240	416	1.0
1	137	VIJAPUR2	139	HIMATNA2	0.00580	0.02910	0.02350	208	1.0
4	131	SOJA2	132	MEHSANA2	0.00160	0.00790	0.10200	832	1.0
1	132	MEHSANA2	134	ANJAR2	0.04320	0.22970	0.19840	208	1.0
1	132	MEHSANA2	158	SANKHAR2	0.01020	0.05440	0.04700	208	1.0
1	158	SANKHAR2	133	DEODAR2	0.02560	0.13600	0.11740	208	1.0
1	133	DEODAR2	134	ANJAR2	0.02790	0.14830	0.12810	208	1.0
2	135	PANANDR2	134	ANJAR2	0.01320	0.07000	0.24200	416	1.0
2	135	PANANDR2	149	NAKHATR2	0.00580	0.03090	0.10680	416	1.0
2	149	NAKHATR2	150	NANIKHA2	0.00500	0.02490	0.08060	416	1.0
1	129	CHHATRA2	128	VIRAMGA2	0.00660	0.03320	0.02690	208	1.0
1	128	VIRAMGA2	168	CHORANI2	0.01120	0.05650	0.04570	208	1.0
1	121	LIMDI2	123	GONDAL2	0.02330	0.12360	0.10670	208	1.0
1	123	GONDAL2	163	RAJKOT2	0.00910	0.04570	0.03700	208	1.0
1	163	RAJKOT2	124	JETPUR2	0.01160	0.05820	0.04700	208	1.0
2	168	CHORANI2	140	DHRANGA2	0.00550	0.02740	0.08880	416	1.0
1	123	GONDAL2	124	JETPUR2	0.00430	0.02160	0.01750	208	1.0
1	124	JETPUR2	138	RANAVAV2	0.01740	0.08730	0.07060	208	1.0
1	124	JETPUR2	152	MOTIPAN2	0.01240	0.06230	0.05040	208	1.0
1	152	MOTIPAN2	138	RANAVAV2	0.01490	0.07480	0.06050	208	1.0
1	124	JETPUR2	127	SAVARKU2	0.01520	0.07650	0.06180	208	1

1	124	JETPUR2	151	VISAVAD2	0.00910	0.04570	0.03700	208	1.0
2	124	JETPUR2	165	JAMNAGA2	0.00660	0.03320	0.10760	416	1.0
1	124	JETPUR2	104	SARDGAD2	0.01080	0.05400	0.04370	208	1.0
1	104	SARDGAD2	125	KESHOD2	0.00830	0.04160	0.03360	208	1.0
1	124	JETPUR2	125	KESHOD2	0.01240	0.06230	0.05040	208	1.0
1	120	KARAMSA2	122	VARTEJ2	0.03220	0.17140	0.14800	208	1.0
3	120	KARAMSA2	169	KASOR2	0.00080	0.00380	0.02820	624	1.0
1	169	KASOR2	122	VARTEJ2	0.03010	0.15990	0.13800	208	1.0
1	122	VARTEJ2	127	SAVARKU2	0.01460	0.07750	0.06690	208	1.0
1	127	SAVARKU2	153	DHOKADV2	0.00910	0.04570	0.03700	208	1.0
1	153	DHOKADV2	126	KODINAR2	0.00910	0.04570	0.03700	208	1.0
1	125	KESHOD2	126	KODINAR2	0.01080	0.05400	0.04370	208	1.0
2	166	DEHGAM2	119	RANASAN2	0.00160	0.00810	0.02640	416	1.0
2	166	DEHGAM2	167	KHANPUR2	0.00100	0.00490	0.01580	416	1.0
2	168	CHORANI2	121	LIMDI2	0.00020	0.00120	0.00400	416	1.0
2	155	JHANOR2	141	HALDARV2	0.00110	0.00530	0.01720	416	1.0
2	142	ICHHAPU2	154	ESSAR2	0.00120	0.00580	0.01880	416	1.0
2	527	ACHHALI1	526	ANKLESH1	0.01350	0.04030	0.01740	168	1.0
1	519	JAMBUVA1	524	MIYAGAM1	0.02320	0.06900	0.00750	84	1.0
1	524	MIYAGAM1	525	BHARUCH1	0.02400	0.07130	0.00780	84	1.0
2	525	BHARUCH1	526	ANKLESH1	0.00390	0.01150	0.00500	168	1.0
2	519	JAMBUVA1	523	JAWAHAR1	0.01430	0.04260	0.01860	168	1.0
2	528	GIPCL1	523	JAWAHAR1	0.00085	0.00415	0.01340	168	1.0
2	522	NANDESA1	521	ASOJ1	0.00740	0.02190	0.00960	168	1.0
2	522	NANDESA1	528	GIPCL1	0.00015	0.00085	0.00260	168	1.0
2	523	JAWAHAR1	520	FERTNGR1	0.00270	0.00800	0.00360	168	1.0
2	518	GOTRI1	520	FERTNGR1	0.00310	0.00920	0.00400	168	1.0
2	520	FERTNGR1	521	ASOJ1	0.00460	0.01380	0.00600	168	1.0
2	519	JAMBUVA1	518	GOTRI1	0.00110	0.00540	0.01740	168	1.0
2	518	GOTRI1	501	DHUVARA1	0.01780	0.05290	0.02300	168	1.0
2	501	DHUVARA1	502	KARAMSA1	0.01585	0.04715	0.02060	168	1.0
2	501	DHUVARA1	503	VATWA1	0.02090	0.06210	0.02700	168	1.0
2	503	VATWA1	504	RANASAN1	0.01010	0.02990	0.01300	168	1.0
2	517	AECOMP1	505	SABARMA1	0.00010	0.00020	0.00020	168	1.0
2	505	SABARMA1	504	RANASAN1	0.00500	0.01500	0.00660	168	1.0
2	501	DHUVARA1	510	LIMDI1	0.04450	0.13230	0.05740	168	1.0
2	510	LIMDI1	507	WANKANE1	0.03640	0.10810	0.04700	168	1.0
1	501	DHUVARA1	511	DHANDHU1	0.07740	0.23000	0.02500	84	1.0
1	511	DHANDHU1	512	PALIAD1	0.04720	0.14030	0.01530	84	1.0
1	512	PALIAD1	513	GONDAL1	0.06730	0.20010	0.02180	84	1.0
1	501	DHUVARA1	514	RAJKOT1	0.19350	0.57500	0.06250	84	1.0
1	514	RAJKOT1	513	GONDAL1	0.02860	0.08510	0.00930	84	1.0
1	513	GONDAL1	515	RANAVAV1	0.11220	0.33350	0.03630	84	1.0
1	515	RANAVAV1	516	BHATIA1	0.06580	0.19550	0.02130	84	1.0
2	509	SIKKA1	508	NAGHEDI1	0.01315	0.03910	0.01700	168	1.0
1	508	NAGHEDI1	507	WANKANE1	0.08440	0.25070	0.02730	84	1.0
1	506	ANJAR1	507	WANKANE1	0.12540	0.37260	0.04050	84	1.0
1	507	WANKANE1	529	JAMNAGA1	0.07740	0.23000	0.02500	84	1.0
1	529	JAMNAGA1	509	SIKKA1	0.03480	0.10350	0.01130	84	1.0
1	529	JAMNAGA1	508	NAGHEDI1	0.00700	0.02070	0.00230	84	1.0
1	530	JAMKHAM1	516	BHATIA1	0.02860	0.08510	0.00930	84	1.0
1	509	SIKKA1	530	JAMKHAM1	0.03100	0.09200	0.01000	84	1.0
1	142	ICHHAPU2	108	VALTHAN2	0.00650	0.03240	0.02620	100	1.0
2	140	DHRANGA2	161	MORVI2	0.00580	0.02910	0.09400	416	1.0
1	55	SOJA4	60	ZERDA4	0.00250	0.02800	0.37480	824	1.0
2	19	SSP4	51	ASOJ4	0.00075	0.00860	0.46080	1648	1.0
2	130	GANDHIN2	159	JAMLA2	0.00175	0.00875	0.02820	416	1.0
2	159	JAMLA2	131	SOJA2	0.00050	0.00250	0.00800	416	1.0
2	167	KHANPUR2	145	KAPADWA2	0.00370	0.01870	0.06040	416	1.0
1	120	KARAMSA2	157	SALEJAD2	0.01210	0.06070	0.04910	208	1.0

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 3  1  157 SALEJAD2   168 CHORANI2    0.01210    0.06070    0.04910     208    1.0
 3  1  106 NAVSARI2   170 CHIKHLI2    0.00410    0.02080    0.01680     208    1.0
 3  1  170 CHIKHLI2   107    VAPI2    0.00760    0.03820    0.03090     208    1.0
 3  2  141 HALDARV2   172   WAGRA2    0.00165    0.00830    0.02680     416    1.0
 3  2  143   ZERDA2   171  THARAD2    0.00465    0.02325    0.07520     416    1.0
 3  1   61    GTEC4    58  JHANOR4    0.00020    0.00210    0.02780     824    1.0
 3  2  141 HALDARV2   173    GTEC2    0.00075    0.00375    0.01200     416    1.0
 3  2  173    GTEC2   120 KARAMSA2    0.00860    0.04320    0.13980     416    1.0
-------------------------------------------------------------------------------
TOTAL LINE CHARGING SUSCEPTANCE           :   27.57080
TOTAL LINE CHARGING MVAR AT 1 PU VOLTAGE :   2757.080
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TOTAL CAPACITIVE SUSCEPTANCE              :    0.00000 pu -    0.000 MVAR
TOTAL INDUCTIVE SUSCEPTANCE               :    0.00000 pu -    0.000 MVAR

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GENERATOR DATA

SL.NO* FROM FROM            REAL       Q-MIN      Q-MAX    V-SPEC CAP.    MVA
       NODE NAME*       POWER(MW)      MVAR       MVAR       P.U. CURV  RATING
-- --- ---- --------  --------- --------- --------- --------- ---- -------
    1     1 DHUVARAG  390.0000    0.0000  164.0000    1.0000    0  100.00
    2     2   SIKKAG  195.0000    0.0000   96.0000    1.0000    0  100.00
    3     3 UKAIHYDG  154.0000    0.0000   49.0000    1.0000    0  100.00
    4     4 UKAITHEG    0.0000    0.0000  223.0000    1.0000    0  100.00
    5     5 WANAKBIG  504.0000    0.0000  212.0000    1.0000    0  100.00
    6     6 WANAKBEG  522.0000    0.0000  250.0000    1.0000    0  100.00
    7     7 GANDHING  615.0000    0.0000  290.0000    1.0000    0  100.00
    8     8 PANANDRG  190.0000    0.0000   80.0000    1.0000    0  100.00
    9     9  KADANAG  200.0000    0.0000   96.0000    1.0000    0  100.00
   10    10  JHANORG  580.0000    0.0000  246.0000    1.0000    0  100.00
   11    11 AECOMPDG  390.0000    0.0000  187.0000    1.0000    0  100.00
   12    12  INDORE4  223.0000 -100.0000  100.0000    1.0000    0  100.00
   13    13   GIPCLG  296.0000    0.0000  124.0000    1.0000    0  100.00
   14    14  UTRANEG  122.0000    0.0000   61.0000    1.0000    0  100.00
   15    15   KAWASG  625.0000    0.0000  263.0000    1.0000    0  100.00
   16    16 KAKRAPAG  390.0000    0.0000  163.0000    1.0000    0  100.00
   17    17   ESSARG  310 0000    0.0000  130.0000    1.0000    0  100.00
   18    18  GTEC-IG  400.0000   67.0000  168.0000    1.0000    0  100.00
   19    19     SSP4   32.0000    0.0000   13.0000    1.0000    0  100.00

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LOAD DATA

SLNO FROM FROM           REAL REACTIVE      COMP COMPENSATING MVAR VALUE CHAR FREQ
*    NODE NAME*            MW     MVAR      MVAR     MIN      MAX   STEP   NO   NO
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   1   12  INDORE4    0.000    0.000 -100.000   0.000   0.000   0.000    0    0
   2   51    ASOJ4    0.000    0.000 -150.000   0.000   0.000   0.000    0    0
   3   53  JETPUR4    0.000    0.000  -50.000   0.000   0.000   0.000    0    0
   4  101   NASIK2  180.000    0.000    0.000   0.000   0.000   0.000    0    0
   5  103 WAGODIA2   50.000   44.000    4.000   0.000   0.000   0.000    0    0
   6  104 SARDGAD2   25.000   22.000   23.000   0.000   0.000   0.000    0    0
   7  105 TARAPUR2   90.000    0.000    0.000   0.000   0.000   0.000    0    0
   8  106 NAVSARI2  290.000  218.000  126.000   0.000   0.000   0.000    0    0
   9  107    VAPI2  280.000  174.000   47.000   0.000   0.000   0.000    0    0
  10  108 VALTHAN2  325.000  202.000   83.000   0.000   0.000   0.000    0    0
  11  110 UKAIHYD2   40.000   30.000    5.000   0.000   0.000   0.000    0    0
  12  111 ACHHALI2  160.000  120.000   46.000   0.000   0.000   0.000    0    0
  13  114 CHANDRA2   60.000   45.000   24.000   0.000   0.000   0.000    0    0
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115	GODHRA2	90.000	68.000	13.000	0.000	0.000	0.000	0	0
118	DHANSUR2	60.000	53.000	20.000	0.000	0.000	0.000	0	0
122	VARTEJ2	140.000	105.000	63.000	0.000	0.000	0.000	0	0
124	JETPUR2	80.000	70.000	50.000	0.000	0.000	0.000	0	0
125	KESHOD2	70.000	62.000	70.000	0.000	0.000	0.000	0	0
126	KODINAR2	60.000	45.000	51.000	0.000	0.000	0.000	0	0
127	SAVARKU2	90.000	79.000	65.000	0.000	0.000	0.000	0	0
128	VIRAMGA2	110.000	83.000	42.000	0.000	0.000	0.000	0	0
129	CHHATRA2	220.000	165.000	113.000	0.000	0.000	0.000	0	0
132	MEHSANA2	340.000	299.000	157.000	0.000	0.000	0.000	0	0
133	DEODAR2	85.000	75.000	85.000	0.000	0.000	0.000	0	0
134	ANJAR2	100.000	88.000	52.000	0.000	0.000	0.000	0	0
135	PANANDR2	20.000	18.000	5.000	0.000	0.000	0.000	0	0
136	PALANPU2	100.000	88.000	55.000	0.000	0.000	0.000	0	0
137	VIJAPUR2	110.000	97.000	88.000	0.000	0.000	0.000	0	0
139	HIMATNA2	80.000	70.000	45.000	0.000	0.000	0.000	0	0
140	DHRANGA2	110.000	97.000	54.000	0.000	0.000	0.000	0	0
141	HALDARV2	100.000	75.000	20.000	0.000	0.000	0.000	0	0
142	ICHHAPU2	75.000	47.000	10.000	0.000	0.000	0.000	0	0
143	ZERDA2	120.000	106.000	94.000	0.000	0.000	0.000	0	0
144	KIM2	125.000	78.000	43.000	0.000	0.000	0.000	0	0
145	KAPADWA2	30.000	26.000	20.000	0.000	0.000	0.000	0	0
146	UTRAN2	110.000	68.000	15.000	0.000	0.000	0.000	0	0
149	NAKHATR2	30.000	26.000	25.000	0.000	0.000	0.000	0	0
150	NANIKHA2	50.000	44.000	10.000	0.000	0.000	0.000	0	0
151	VISAVAD2	30.000	26.000	28.000	0.000	0.000	0.000	0	0
152	MOTIPAN2	30.000	26.000	15.000	0.000	0.000	0.000	0	0
153	DHOKADV2	15.000	13.000	10.000	0.000	0.000	0.000	0	0
156	ZAGADIA2	30.000	19.000	0.000	0.000	0.000	0.000	0	0
157	SALEJAD2	50.000	38.000	15.000	0.000	0.000	0.000	0	0
158	SANKHAR2	50.000	44.000	20.000	0.000	0.000	0.000	0	0
159	JAMLA2	45.000	40.000	37.000	0.000	0.000	0.000	0	0
160	KHERALU2	30.000	26.000	20.000	0.000	0.000	0.000	0	0
161	MORVI2	80.000	60.000	20.000	0.000	0.000	0.000	0	0
163	RAJKOT2	110.000	68.000	23.000	0.000	0.000	0.000	0	0
165	JAMNAGA2	80.000	60.000	20.000	0.000	0.000	0.000	0	0
167	KHANPUR2	60.000	45.000	30.000	0.000	0.000	0.000	0	0
170	CHIKHLI2	20.000	15.000	5.000	0.000	0.000	0.000	0	0
171	THARAD2	30.000	26.000	20.000	0.000	0.000	0.000	0	0
172	WAGRA2	35.000	26.000	0.000	0.000	0.000	0.000	0	0
502	KARAMSA1	135.000	101.000	54.000	0.000	0.000	0.000	0	0
503	VATWA1	80.000	60.000	30.000	0.000	0.000	0.000	0	0
504	RANASAN1	180.000	135.000	150.000	0.000	0.000	0.000	0	0
506	ANJAR1	65.000	49.000	35.000	0.000	0.000	0.000	0	0
507	WANKANE1	65.000	57.000	46.000	0.000	0.000	0.000	0	0
508	NAGHEDI1	45.000	34.000	25.000	0.000	0.000	0.000	0	0
509	SIKKA1	20.000	15.000	8.000	0.000	0.000	0.000	0	0
510	LIMDI1	60.000	53.000	24.000	0.000	0.000	0.000	0	0
511	DHANDHU1	20.000	18.000	3.000	0.000	0.000	0.000	0	0
512	PALIAD1	35.000	31.000	20.000	0.000	0.000	0.000	0	0
513	GONDAL1	140.000	123.000	110.000	0.000	0.000	0.000	0	0
514	RAJKOT1	45.000	28.000	20.000	0.000	0.000	0.000	0	0
515	RANAVAV1	90.000	68.000	83.000	0.000	0.000	0.000	0	0
516	BHATIA1	40.000	35.000	5.000	0.000	0.000	0.000	0	0
517	AECOMP1	450.000	279.000	156.000	0.000	0.000	0.000	0	0
518	GOTRI1	100.000	62.000	69.000	0.000	0.000	0.000	0	0
519	JAMBUVA1	100.000	75.000	99.000	0.000	0.000	0.000	0	0
520	FERTNGR1	35.000	22.000	0.000	0.000	0.000	0.000	0	0
521	ASOJ1	60.000	37.000	40.000	0.000	0.000	0.000	0	0
522	NANDESA1	35.000	22.000	0.000	0.000	0.000	0.0		

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 74  523 JAWAHAR1    50.000   31.000     0.000    0.000    0.000    0.000     0     0
 75  530 JAMKHAM1    15.000   13.000     7.000    0.000    0.000    0.000     0     0
-------------------------------------------------------------------------------------
TAL SPECIFIED MW GENERATION              : 6138.00000
TAL MIN MVAR LIMIT OF GENERATOR          :  -33.00000
TAL MAX MVAR LIMIT OF GENERATOR          : 2915.00000
TAL SPECIFIED MW LOAD                    : 6565.00000
TAL SPECIFIED MVAR LOAD                  : 4767.00000
TAL SPECIFIED MVAR COMPENSATION          : 2570.00000

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NERATOR DATA FOR FREQUENCY DEPENDENT LOAD FLOW

GNO*  FROM FROM        P-RATE     P-MIN       P-MAX    %DROOP     PARTICI      BIAS
      NODE NAME*           MW        MW          MW                FACTOR   SETTING
                                                             C0        C1        C2
----- ---- --------- -------- --------- --------- --------- --------- ---------
    1    1 DHUVARAG    70.000    0.0000  390.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    2    2   SIKKAG    70.000    0.0000  195.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    3    3 UKAIHYDG    70.000    0.0000  154.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    4    4 UKAITHEG    70.000    0.0000  700.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    5    5 WANAKBIG    70.000    0.0000  504.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    6    6 WANAKBEG    70.000    0.0000  522.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    7    7 GANDHING    70.000    0.0000  615.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    8    8 PANANDRG    70.000    0.0000  190.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
    9    9  KADANAG    70.000    0.0000  200.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   10   10  JHANORG    70.000    0.0000  580.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   11   11 AECOMPDG    70.000    0.0000  390.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   12   12  INDORE4    70.000    0.0000  223.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   13   13   GIPCLG    70.000    0.0000  296.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   14   14  UTRANEG    70.000    0.0000  122.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   15   15   KAWASG    70.000    0.0000  625.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   16   16 KAKRAPAG    70.000    0.0000  390.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   17   17   ESSARG    70.000    0.0000  310.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   18   18  GTEC-IG    70.000    0.0000  400.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
   19   19     SSP4    70.000    0.0000   32.0000    4.0000    0.0000    0.0000
                                                     0.0000    0.0000    0.0000
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TERATION     MAX P BUS      MAX P    MAX Q BUS      MAX Q
  COUNT         NUMBER   PER UNIT       NUMBER   PER UNIT
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----  --       -----------  --- --          -------- - --- -
        1           15       6.140              155      6.536
        2          155       1.114              155      0.159
        3          109       0.056               53      0.020
        4           51       0.010               53      0.004
        5           51       0.002               18      2.927
        6           18       0.633              173      0.050
        7          173       0.009              146      0.013
        8          146       0.002               53      0.001
        9           53       0.000               53      0.001

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BUS VOLTAGES AND POWERS

NODE FROM       V-MAG  ANGLE        MW      MVAR        MW      MVAR      MVAR
NO.  NAME        P.U. DEGREE       GEN       GEN      LOAD      LOAD      COMP
---- --------  ------ ------  --------  --------  --------  --------  --------
   1 DHUVARAG  1.0000  -7.68   390.000    35.588     0.000     0.000     0.000
   2   SIKKAG  1.0000 -17.46   195.000    53.613     0.000     0.000     0.000
   3 UKAIHYDG  1.0000  -2.03   154.000    29.678     0.000     0.000     0.000
   4 UKAITHEG  1.0000   0.00   613.806    38.276     0.000     0.000     0.000
   5 WANAKBIG  1.0000  -3.78   504.000    27.896     0.000     0.000     0.000
   6 WANAKBEG  1.0000  -4.51   522.000   206.463     0.000     0.000     0.000
   7 GANDHING  1.0000  -9.04   615.000    94.991     0.000     0.000     0.000
   8 PANANDRG  1.0000 -18.89   190.000    24.767     0.000     0.000     0.000
   9  KADANAG  1.0000  -3.86   200.000     9.000     0.000     0.000     0.000
  10  JHANORG  1.0000   2.74   580.000     4.939     0.000     0.000     0.000
  11 AECOMPDG  1.0000  -9.50   390.000    91.332     0.000     0.000     0.000
  12  INDORE4  1.0000  -7.69   223.000   -57.263     0.000     0.000  -100.000
  13   GIPCLG  1.0000  -3.49   296.000     7.727     0.000     0.000     0.000
  14  UTRANEG  1.0000  -1.88   122.000    58.909     0.000     0.000     0.000
  15   KAWASG  1.0000   3.51   625.000   113.820     0.000     0.000     0.000
  16 KAKRAPAG  1.0000   0.94   390.000    97.086     0.000     0.000     0.000
  17   ESSARG  1.0000   1.11   310.000    83.587     0.000     0.000     0.000
  18  GTEC-IG  1.0843  -0.36   400.000    67.000     0.000     0.000     0.000
  19     SSP4  1.0000 -11.42    32.000     7.980     0.000     0.000     0.000
  51    ASOJ4  0.9951 -11.55     0.000     0.000     0.000     0.000  -150.000
  52 WANAKBO4  1.0081 -10.44     0.000     0.000     0.000     0.000     0.000
  53  JETPUR4  0.9527 -22.01     0.000     0.000     0.000     0.000   -50.000
  54 UKAITHE4  0.9926  -8.43     0.000     0.000     0.000     0.000     0.000
  55    SOJA4  0.9962 -12.84     0.000     0.000     0.000     0.000     0.000
  56   KASOR4  0.9837 -12.94     0.000     0.000     0.000     0.000     0.000
  57 CHORANI4  0.9732 -16.21     0.000     0.000     0.000     0.000     0.000
  58  JHANOR4  1.0147  -4.76     0.000     0.000     0.000     0.000     0.000
  59  DEHGAM4  1.0068  -8.67     0.000     0.000     0.000     0.000     0.000
  60   ZERDA4  1.0117 -15.35     0.000     0.000     0.000     0.000     0.000
  61    GTEC4  1.0177  -4.70     0.000     0.000     0.000     0.000     0.000
 101   NASIK2  0.9753 -15.20     0.000     0.000   180.000     0.000     0.000
 103 WAGODIA2  1.0207 -10.27     0.000     0.000    50.000    44.000     4.000
 104 SARDGAD2  0.9896 -27.76     0.000     0.000    25.000    22.000    23.000
 105 TARAPUR2  0.9682 -11.87     0.000     0.000    90.000     0.000     0.000
 106 NAVSARI2  0.9921  -7.48     0.000     0.000   290.000   218.000   126.000
 107    VAPI2  0.9597 -10.48     0.000     0.000   280.000   174.000    47.000
 108 VALTHAN2  1.0052  -5.95     0.000     0.000   325.000   202.000    83.000
 109 UKAITHE2  1.0299  -4.72     0.000     0.000     0.000     0.000     0.000
 110 UKAIHYD2  1.0300  -4.81     0.000     0.000    40.000    30.000     5.000
 111 ACHHALI2  1.0218  -8.02     0.000     0.000   160.000   120.000    46.000
 112 JAMBUVA2  1.0227  -9.37     0.000     0.000     0.000     0.000     0.000
 113    ASOJ2  1.0301 -10.74     0.000     0.000     0.000     0.000     0.000
 114 CHANDPA2  1.0279 -10.75     0.000     0.000    60.000    45.000    24.000
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115  GODHRA2  1.0286 -10.31   0.000   0.000    90.000   68.000   13.000
116 WANAKBO2  1.0392  -9.40   0.000   0.000     0.000    0.000    0.000
117  KADANA2  1.0363  -8.88   0.000   0.000     0.000    0.000    0.000
118 DHANSUR2  1.0284 -10.83   0.000   0.000    60.000   53.000   20.000
119 RANASAN2  1.0260 -12.54   0.000   0.000     0.000    0.000    0.000
120 KARAMSA2  1.0219 -11.59   0.000   0.000     0.000    0.000    0.000
121   LIMDI2  0.9951 -19.22   0.000   0.000     0.000    0.000    0.000
122  VARTEJ2  0.9736 -23.10   0.000   0.000   140.000  105.000   63.000
123  GONDAL2  0.9752 -26.61   0.000   0.000     0.000    0.000    0.000
124  JETPUR2  0.9894 -25.87   0.000   0.000    80.000   70.000   50.000
125  KESHOD2  0.9889 -28.58   0.000   0.000    70.000   62.000   70.000
126 KODINAR2  0.9850 -29.64   0.000   0.000    60.000   45.000   51.000
127 SAVARKU2  0.9771 -27.61   0.000   0.000    90.000   79.000   65.000
128 VIRAMGA2  0.9897 -18.23   0.000   0.000   110.000   83.000   42.000
129 CHHATRA2  1.0060 -15.73   0.000   0.000   220.000  165.000  113.000
130 GANDHIN2  1.0226 -13.54   0.000   0.000     0.000    0.000    0.000
131    SOJA2  1.0203 -14.62   0.000   0.000     0.000    0.000    0.000
132 MEHSANA2  1.0034 -16.95   0.000   0.000   340.000  299.000  157.000
133  DEODAR2  1.0111 -27.52   0.000   0.000    85.000   75.000   85.000
134   ANJAR2  1.0074 -26.82   0.000   0.000   100.000   88.000   52.000
135 PANANDR2  1.0331 -23.57   0.000   0.000    20.000   18.000    5.000
136 PALANPU2  0.9842 -17.25   0.000   0.000   100.000   88.000   55.000
137 VIJAPUR2  1.0177 -14.73   0.000   0.000   110.000   97.000   88.000
138 RANAVAV2  0.9798 -28.66   0.000   0.000     0.000    0.000    0.000
139 HIMATNA2  1.0175 -13.30   0.000   0.000    80.000   70.000   45.000
140 DHRANGA2  0.9665 -22.04   0.000   0.000   110.000   97.000   54.000
141 HALDARV2  1.0273  -4.00   0.000   0.000   100.000   75.000   20.000
142 ICHHAPU2  1.0220  -2.75   0.000   0.000    75.000   47.000   10.000
143   ZERDA2  0.9778 -17.17   0.000   0.000   120.000  106.000   94.000
144     KIM2  1.0018  -6.38   0.000   0.000   125.000   78.000   43.000
145 KAPADWA2  1.0345 -11.29   0.000   0.000    30.000   26.000   20.000
146   UTRAN2  1.0017  -6.31   0.000   0.000   110.000   68.000   15.000
147   KAWAS2  1.0206  -2.93   0.000   0.000     0.000    0.000    0.000
148 KAKRAPA2  1.0172  -4.28   0.000   0.000     0.000    0.000    0.000
149 NAKHATR2  1.0260 -24.88   0.000   0.000    30.000   26.000   25.000
150 NANIKHA2  1.0172 -25.50   0.000   0.000    50.000   44.000   10.000
151 VISAVAD2  0.9891 -26.70   0.000   0.000    30.000   26.000   28.000
152 MOTIPAN2  0.9825 -27.73   0.000   0.000    30.000   26.000   15.000
153 DHOKADV2  0.9812 -28.85   0.000   0.000    15.000   13.000   10.000
 54   ESSAR2  1.0293  -1.82   0.000   0.000     0.000    0.000    0.000
 55  JHANOR2  1.0402  -3.15   0.000   0.000     0.000    0.000    0.000
 56 ZAGADIA2  1.0078  -5.73   0.000   0.000    30.000   19.000    0.000
 57 SALEJAD2  0.9994 -16.13   0.000   0.000    50.000   38.000   15.000
 58 SANKHAR2  0.9953 -21.06   0.000   0.000    50.000   44.000   20.000
 59   JAMLA2  1.0206 -14.43   0.000   0.000    45.000   40.000   37.000
 60 KHERALU2  0.9985 -16.52   0.000   0.000    30.000   26.000   20.000
 61   MORVI2  0.9517 -23.38   0.000   0.000    80.000   60.000   20.000
 63  RAJKOT2  0.9654 -27.87   0.000   0.000   110.000   68.000   23.000
 65 JAMNAGA2  0.9784 -26.44   0.000   0.000    80.000   60.000   20.000
 66  DEHGAM2  1.0370 -11.48   0.000   0.000     0.000    0.000    0.000
 67 KHANPUR2  1.0358 -11.56   0.000   0.000    60.000   45.000   30.000
 68 CHORANI2  0.9956 -19.13   0.000   0.000     0.000    0.000    0.000
 69   KASOR2  1.0229 -12.05   0.000   0.000     0.000    0.000    0.000
 70 CHIKHLI2  0.9791  -8.67   0.000   0.000    20.000   15.000    5.000
 71  THARAD2  0.9766 -17.59   0.000   0.000    30.000   26.000   20.000
 72   WAGRA2  1.0248  -4.14   0.000   0.000    35.000   26.000    0.000
 73    GTEC2  1.0255  -3.94   0.000   0.000     0.000    0.000    0.000
  1 DHUVARA1  1.0423 -11.65   0.000   0.000     0.000    0.000    0.000
  2 KARAMSA1  1.0279 -13.31   0.000   0.000   135.000  101.000   54.000
  3   VATWA1  1.0266 -14.49   0.000   0.000    80.000   60.000   30.000
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504 RANASAN1  1.0350 -14.72    0.000    0.000   180.000  135.000  150.000
505 SABARMA1  1.0216 -15.03    0.000    0.000     0.000    0.000    0.000
506   ANJAR1  1.0231 -28.00    0.000    0.000    65.000   49.000   35.000
507 WANKANE1  1.0013 -24.36    0.000    0.000    65.000   57.000   46.000
508 NAGHEDI1  1.0127 -23.68    0.000    0.000    45.000   34.000   25.000
509   SIKKA1  1.0255 -22.21    0.000    0.000    20.000   15.000    8.000
510   LIMDI1  1.0099 -19.77    0.000    0.000    60.000   53.000   24.000
511 DHANDHU1  0.9577 -21.55    0.000    0.000    20.000   18.000    3.000
512  PALIAD1  0.9459 -26.74    0.000    0.000    35.000   31.000   20.000 @
513  GONDAL1  0.9774 -29.97    0.000    0.000   140.000  123.000  110.000
514  RAJKOT1  0.9666 -29.50    0.000    0.000    45.000   28.000   20.000
515 RANAVAV1  0.9985 -30.74    0.000    0.000    90.000   68.000   83.000
516  BHATIA1  0.9660 -28.28    0.000    0.000    40.000   35.000    5.000
517  AECOMP1  1.0214 -15.04    0.000    0.000   450.000  279.000  156.000
518   GOTRI1  1.0418 -11.25    0.000    0.000   100.000   62.000   69.000
519 JAMBUVA1  1.0431 -11.17    0.000    0.000   100.000   75.000   99.000
520 FERTNGR1  1.0412 -10.79    0.000    0.000    35.000   22.000    0.000
521    ASOJ1  1.0439 -10.77    0.000    0.000    60.000   37.000   40.000
522 NANDESA1  1.0425  -9.90    0.000    0.000    35.000   22.000    0.000
523 JAWAHAR1  1.0417 -10.29    0.000    0.000    50.000   31.000    0.000
524 MIYAGAM1  1.0468 -10.22    0.000    0.000     0.000    0.000    0.000
525 BHARUCH1  1.0498  -9.22    0.000    0.000     0.000    0.000    0.000
526 ANKLESH1  1.0501  -9.05    0.000    0.000     0.000    0.000    0.000 #
527 ACHHALI1  1.0505  -8.46    0.000    0.000     0.000    0.000    0.000 #
528   GIPCL1  1.0426  -9.86    0.000    0.000     0.000    0.000    0.000
529 JAMNAGA1  1.0110 -23.90    0.000    0.000     0.000    0.000    0.000
530 JAMKHAM1  0.9891 -25.63    0.000    0.000    15.000   13.000    7.000
--------------------------------------------------------------------------------
NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark)  :    1
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark)  :    3
NUMBER OF GENERATORS EXCEEDING MINIMUM Q LIMIT (< mark)   :    0
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark)   :    0

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LINE FLOWS AND LINE LOSSES

SLNO FROM FROM       TO TO              FORWARD             LOSS          %
     NODE NAME     NODE NAME          MW      MVAR       MW      MVAR   LOADING
---- ---- -------- ---- -------- -------- -------- -------- -------- --------
   1  501 DHUVARA1    1 DHUVARAG -368.645   -8.476   1.3556  27.1121    55.2$
   2  509   SIKKA1    2   SIKKAG -194.140  -36.416   0.8599  17.1971    67.4$
   3  110 UKAIHYD2    3 UKAIHYDG -153.613  -21.940   0.3869   7.7383    46.1
   4  109 UKAITHE2    4 UKAITHEG -611.275   12.342   2.5309  50.6186    60.9$
   5   54 UKAITHE4  109 UKAITHE2 -186.587   58.048   0.6410  12.8196    62.0$
   6  116 WANAKBO2    5 WANAKBIG -501.532   21.472   2.4684  49.3684    67.3$
   7   52 WANAKBO4    6 WANAKBEG -518.947 -145.407   3.0528  61.0552    74.8$
   8   52 WANAKBO4  116 WANAKBO2  -44.002   57.341   0.0985   1.9694    22.9&
   9  130 GANDHIN2    7 GANDHING -612.544  -45.871   2.4559  49.1192    60.4$
  10  135 PANANDR2    8 PANANDRG -189.215   -9.073   0.7847  15.6937    63.9$
  11  117  KADANA2    9  KADANAG -199.125    8.494   0.8747  17.4936    66.7$
  12  517  AECOMP1   11 AECOMPDG -388.037  -52.073   1.9629  39.2591    72.2$
  13  528   GIPCL1   13   GIPCLG -294.358   25.110   1.6419  32.8374    74.0$
  14   51    ASOJ4  113    ASOJ2 -118.125  156.368   0.2132   4.2648    19.6&
  15  113    ASOJ2  521    ASOJ1    3.897   42.114   0.0252   0.5042    14.1&
  16   53  JETPUR4  124  JETPUR2  552.763  101.434   1.9133  38.2655    59.5$
  17   55    SOJA4  131    SOJA2  275.697  226.556   0.7286  14.5720    35.7
  18  111 ACHHALI2  527 ACHHALI1   25.724   -9.228   0.0111   0.2228     9.1&
  19  112 JAMBUVA2  519 JAMBUVA1   70.481   10.088   0.1132   2.2639    35.6
  20  119 RANASAN2  504 RANASAN1  239.047   95.463   0.5289  10.5777    46.8
  21  120 KARAMSA2  502 KARAMSA1   66.784   40.123   0.1377   2.7539    39.
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22	121	LIMDI2	510	LIMDI1	24.676	24.947	0.0249	0.4982	17.5&
23	123	GONDAL2	513	GONDAL1	119.069	44.003	0.3957	7.9144	63.5$
24	134	ANJAR2	506	ANJAR1	51.389	22.153	0.0634	1.2687	28.0^
25	138	RANAVAV2	515	RANAVAV1	74.661	10.639	0.1384	2.7677	37.7^
26	57	CHORANI4	168	CHORANI2	212.106	112.210	0.6904	13.8084	48.0^
27	58	JHANOR4	155	JHANOR2	-236.742	252.029	0.6594	13.1884	34.6^
28	56	KASOR4	169	KASOR2	-85.029	76.177	0.1117	2.2336	18.1&
29	59	DEHGAM4	166	DEHGAM2	298.651	123.576	0.8546	17.0912	51.3$
30	146	UTRAN2	14	UTRANEG	-121.426	-47.452	0.5729	11.4570	67.7$
31	147	KAWAS2	15	KAWASG	-621.413	-42.072	3.5873	71.7476	85.8#
32	148	KAKRAPA2	16	KAKRAPAG	-388.137	-59.820	1.8633	37.2659	77.3#
33	155	JHANOR2	10	JHANORG	-577.026	54.533	2.9737	59.4729	77.3#
34	154	ESSAR2	17	ESSARG	-309.150	-66.600	0.8494	16.9881	44.0^
35	165	JAMNAGA2	529	JAMNAGA1	-45.925	-4.298	0.1038	2.0763	46.5^
36	60	ZERDA4	143	ZERDA2	151.104	-34.424	0.2514	5.0289	24.8&
37	18	GTEC-IG	173	GTEC2	400.000	67.002	1.2818	25.6353	48.1^
38	173	GTEC2	61	GTEC4	64.080	141.007	0.2707	5.4139	31.0^
39	54	UKAITHE4	51	ASOJ4	186.592	-58.053	0.9297	-65.2404	23.7&
40	51	ASOJ4	53	JETPUR4	273.507	-19.773	4.6324	-111.9780	34.5^
41	52	WANAKBO4	51	ASOJ4	133.757	53.054	0.3218	-37.6734	19.6&
42	52	WANAKBO4	55	SOJA4	429.192	35.010	1.7027	-89.2676	27.0^
43	51	ASOJ4	57	CHORANI4	236.040	6.832	1.8285	-68.1565	29.8^
4	56	KASOR4	57	CHORANI4	265.886	6.014	1.4092	-37.7309	32.5^
45	57	CHORANI4	53	JETPUR4	286.583	6.505	2.6760	-52.7772	35.2^
46	58	JHANOR4	59	DEHGAM4	300.502	-111.172	1.8479	-234.7540	19.6&
47	51	ASOJ4	56	KASOR4	181.312	52.014	0.4575	-30.1747	24.1&
48	12	INDORE4	51	ASOJ4	223.000	-157.262	1.3431	-305.4578	16.6&
49	105	TARAPUR2	106	NAVSARI2	-59.822	-13.826	0.9518	-14.5844	29.5^
50	105	TARAPUR2	107	VAPI2	-30.180	13.822	0.1784	-9.0995	18.3&
51	101	NASIK2	106	NAVSARI2	-180.003	-0.012	4.6056	-22.6547	44.7^
52	106	NAVSARI2	108	VALTHAN2	-210.750	-57.224	1.2715	-2.1954	52.7$
53	109	UKAITHE2	108	VALTHAN2	101.846	70.823	0.8037	-13.1662	31.6^
54	109	UKAITHE2	111	ACHHALI2	264.007	-24.102	2.8265	-22.2679	42.5^
55	109	UKAITHE2	110	UKAIHYD2	58.188	-13.827	0.0167	-1.6984	14.4&
56	148	KAKRAPA2	108	VALTHAN2	178.348	30.980	1.1218	-5.9255	43.5^
57	148	KAKRAPA2	141	HALDARV2	-22.478	-39.455	0.0791	-20.1248	10.9&
58	148	KAKRAPA2	107	VAPI2	232.269	68.300	5.7892	-2.0708	58.2$
59	110	UKAIHYD2	111	ACHHALI2	171.783	-15.193	1.7807	-15.3639	41.5^
60	146	UTRAN2	144	KIM2	11.420	-5.571	0.0027	-6.5693	3.1&
61	147	KAWAS2	106	NAVSARI2	436.912	75.775	7.2104	23.7223	106.6@
62	147	KAWAS2	108	VALTHAN2	184.256	17.885	1.9796	4.9320	89.0#
63	147	KAWAS2	141	HALDARV2	51.928	-41.317	0.2313	-21.6515	16.0&
64	147	KAWAS2	142	ICHHAPU2	-51.682	-10.271	0.0372	-0.9512	25.3^
65	108	VALTHAN2	144	KIM2	44.718	9.455	0.0734	-2.4727	22.2&
66	144	KIM2	156	ZAGADIA2	-68.937	-22.069	0.1806	-1.9440	34.8^
67	156	ZAGADIA2	141	HALDARV2	-99.117	-39.124	0.7460	-1.9750	51.2$
68	141	HALDARV2	112	JAMBUVA2	150.677	-20.837	2.7607	3.0487	73.1$
69	108	VALTHAN2	112	JAMBUVA2	58.035	-35.844	0.7886	-12.0800	32.8^
70	111	ACHHALI2	112	JAMBUVA2	245.456	-66.447	1.0863	-22.0688	30.6^
71	112	JAMBUVA2	113	ASOJ2	115.826	-59.956	0.5942	-0.4230	62.7$
72	112	JAMBUVA2	103	WAGODIA2	74.788	-5.940	0.2199	-2.7405	36.1^
73	103	WAGODIA2	113	ASOJ2	24.568	-43.202	0.1090	-4.2193	23.9&
74	112	JAMBUVA2	120	KARAMSA2	188.433	-36.230	1.4252	-6.8157	46.1^
75	113	ASOJ2	120	KARAMSA2	91.979	23.471	0.3002	-11.5814	23.6&
76	116	WANAKBO2	113	ASOJ2	79.906	2.911	0.3965	-20.4627	19.9&
77	116	WANAKBO2	115	GODHRA2	63.643	23.135	0.2529	-3.7556	33.1^
78	116	WANAKBO2	118	DHANSUR2	111.512	15.552	0.6029	-14.2265	27.6^
79	116	WANAKBO2	119	RANASAN2	91.176	-0.068	0.9967	-6.1686	43.8^
80	116	WANAKBO2	145	KAPADWA2	111.192	-7.634	0.7226	-1.8589	53.6$
81	145	KAPADWA2	119	RANASAN2	56.055	6.471	0.2578	-6.0474	27.5^

82	117	KADANA2	115	GODHRA2	82.132	-2.818	0.4192	-20.8324	20.1&
83	115	GODHRA2	114	CHANDRA2	55.104	-10.095	0.0781	-10.1145	13.5&
84	114	CHANDRA2	113	ASOJ2	-4.974	-20.985	0.0068	-9.6207	5.2&
85	117	KADANA2	118	DHANSUR2	116.993	-5.676	0.7917	-17.5024	28.2^
86	118	DHANSUR2	139	HIMATNA2	167.111	8.605	1.4586	2.6202	80.4#
87	120	KARAMSA2	119	RANASAN2	55.816	-34.923	0.1922	-19.8596	15.8&
88	130	GANDHIN2	119	RANASAN2	-222.813	0.631	0.7598	-2.1076	53.7$
89	130	GANDHIN2	131	SOJA2	294.259	-21.392	1.0809	0.9804	70.9$
90	130	GANDHIN2	129	CHHATRA2	358.580	81.306	2.8586	6.7525	88.4#
91	131	SOJA2	136	PALANPU2	65.428	28.311	0.8299	-8.6517	35.8^
92	131	SOJA2	160	KHERALU2	65.347	22.743	0.5408	-6.5852	34.2^
93	160	KHERALU2	136	PALANPU2	34.807	23.328	0.1624	-5.9226	21.8&
94	136	PALANPU2	143	ZERDA2	-0.757	33.212	0.0503	-10.1024	10.4&
95	131	SOJA2	137	VIJAPUR2	24.795	18.669	0.0211	-6.6226	8.5&
96	137	VIJAPUR2	139	HIMATNA2	-85.226	16.291	0.4264	-2.7271	42.2^
97	131	SOJA2	132	MEHSANA2	549.450	106.504	4.8509	3.0624	67.3$
98	132	MEHSANA2	134	ANJAR2	73.745	-29.043	2.3685	-27.5164	38.1^
99	132	MEHSANA2	158	SANKHAR2	130.853	-9.536	1.7369	-0.1251	63.1$
100	158	SANKHAR2	133	DEODAR2	79.116	-33.417	1.7402	-14.3887	41.3^
101	133	DEODAR2	134	ANJAR2	-7.626	-9.032	0.0204	-25.9882	8.9&
102	135	PANANDR2	134	ANJAR2	88.705	-2.127	1.0426	-44.8595	23.4&
103	135	PANANDR2	149	NAKHATR2	80.510	-1.802	0.3572	-20.7395	19.8&
.04	149	NAKHATR2	150	NANIKHA2	50.153	17.937	0.1526	-16.0648	14.5&
105	129	CHHATRA2	128	VIRAMGA2	135.722	22.548	1.2429	0.8942	66.1$
106	128	VIRAMGA2	168	CHORANI2	24.478	-19.353	0.0938	-8.5331	15.0&
107	121	LIMDI2	123	GONDAL2	101.604	-7.189	2.4317	-7.8144	49.0^
108	123	GONDAL2	163	RAJKOT2	47.711	8.464	0.2315	-5.8045	23.8&
109	163	RAJKOT2	124	JETPUR2	-62.524	-30.750	0.5731	-6.1058	33.5^
110	168	CHORANI2	140	DHRANGA2	192.823	62.698	2.3468	-5.4052	48.7^
111	123	GONDAL2	124	JETPUR2	-67.611	-51.853	0.3206	-1.7672	41.0^
112	124	JETPUR2	138	RANAVAV2	54.450	-5.506	0.5273	-11.0425	26.3^
113	124	JETPUR2	152	MOTIPAN2	51.142	-3.331	0.3316	-8.1328	24.6&
114	152	MOTIPAN2	138	RANAVAV2	20.809	-6.202	0.0669	-11.3121	10.4&
115	124	JETPUR2	127	SAVARKU2	40.213	2.481	0.2624	-10.6292	20.2&
116	124	JETPUR2	151	VISAVAD2	30.088	-8.805	0.0867	-6.8069	15.1&
117	124	JETPUR2	165	JAMNAGA2	34.201	15.508	0.1246	-20.2074	11.9&
118	124	JETPUR2	104	SARDGAD2	57.837	-15.292	0.3824	-6.6457	28.8^
119	104	SARDGAD2	125	KESHOD2	32.454	-7.648	0.0909	-6.1209	16.0&
120	124	JETPUR2	125	KESHOD2	71.902	-16.616	0.6722	-6.4850	35.5^
121	120	KARAMSA2	122	VARTEJ2	119.183	2.625	4.4809	-5.6304	57.3$
122	120	KARAMSA2	169	KASOR2	208.536	-72.600	0.3703	-4.1361	35.4^
123	169	KASOR2	122	VARTEJ2	123.026	5.471	4.4684	-3.7809	59.2$
.24	122	VARTEJ2	127	SAVARKU2	93.258	-24.523	1.3906	-5.3463	46.4^
125	127	SAVARKU2	153	DHOKADV2	41.814	-20.080	0.1928	-6.1263	22.3&
126	153	DHOKADV2	126	KODINAR2	26.620	-16.956	0.0839	-6.7303	15.2&
127	125	KESHOD2	126	KODINAR2	33.590	-3.662	0.1247	-7.8899	16.2&
128	166	DEHGAM2	119	RANASAN2	262.169	89.374	1.1491	0.1989	66.6$
129	166	DEHGAM2	167	KHANPUR2	35.627	17.113	0.0151	-3.3205	9.9&
130	168	CHORANI2	121	LIMDI2	126.310	17.168	0.0328	-0.5957	30.7^
131	155	JHANOR2	141	HALDARV2	339.622	184.308	1.5248	3.6706	92.9#
132	142	ICHHAPU2	154	ESSAR2	-308.017	-65.064	1.1358	1.5348	76.0#
133	527	ACHHALI1	526	ANKLESH1	25.714	-9.447	0.0878	-3.5768	16.3&
134	519	JAMBUVA1	524	MIYAGAM1	-25.318	2.338	0.1388	-1.2250	30.6^
135	524	MIYAGAM1	525	BHARUCH1	-25.457	3.563	0.1462	-1.2799	31.0^
136	525	BHARUCH1	526	ANKLESH1	-25.603	4.840	0.0242	-1.0310	15.6&
137	519	JAMBUVA1	523	JAWAHAR1	-34.350	13.186	0.1855	-3.4896	22.8&
138	528	GIPCL1	523	JAWAHAR1	193.800	-17.514	0.2957	-1.4671	115.8@
139	522	NANDESA1	521	ASOJ1	65.531	-29.121	0.3461	-1.0654	42.7^
140	522	NANDESA1	528	GIPCL1	-100.534	7.111	0.0140	-0.4858	60.0$
141	523	JAWAHAR1	520	FERTNGR1	108.972	-30.376	0.3178	0.1608	67.3$

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  2  518   GOTRI1  520 FERTNGR1   -82.466   34.538  0.2292  -0.1877     53.4$
  3  520 FERTNGR1  521    ASOJ1    -9.041  -17.809  0.0160  -1.2565     11.9&
  4  519 JAMBUVA1  518   GOTRI1    30.034   16.306  0.0125  -3.7206     21.5&
  5  518   GOTRI1  501 DHUVARA1    12.488   -7.511  0.0297  -4.9067      8.7&
  6  501 DHUVARA1  502 KARAMSA1    69.062    7.325  0.7092  -2.3044     41.3^
  7  501 DHUVARA1  503   VATWA1    85.408   -3.206  1.4034  -1.6085     50.9$
  8  503   VATWA1  504 RANASAN1     4.003  -31.598  0.0891  -2.4988     19.0&
  9  517  AECOMP1  505 SABARMA1   -62.005  -70.985  0.0085  -0.0247     56.1$
 50  505 SABARMA1  504 RANASAN1   -62.016  -70.927  0.4206  -0.1341     56.2$
 51  501 DHUVARA1  510   LIMDI1   111.088  -10.095  5.0613   2.9580     66.4$
 52  510   LIMDI1  507 WANKANE1    70.679  -17.607  1.8416  -4.0364     43.4^
153  501 DHUVARA1  511 DHANDHU1    80.592   14.963  4.8504   9.4047     97.6#
154  511 DHANDHU1  512  PALIAD1    55.745   -9.446  1.6325   2.0806     67.3$
155  512  PALIAD1  513  GONDAL1    19.108  -22.536  0.5934  -2.2684     35.2^
156  501 DHUVARA1  514  RAJKOT1    54.955   -3.132  5.4033   3.4269     65.5$
157  514  RAJKOT1  513  GONDAL1     4.549  -14.570  0.0638  -1.5675     18.2&
158  513  GONDAL1  515 RANAVAV1     1.669  -10.196  0.0564  -6.9191     12.3&
159  515 RANAVAV1  516  BHATIA1   -13.866   19.595  0.4382  -2.8094     31.6^
160  509   SIKKA1  508 NAGHEDI1    71.326    8.791  0.6501  -1.5985     42.8^
161  508 NAGHEDI1  507 WANKANE1     5.768   -0.120  0.0333  -5.4381      9.3&
162  506   ANJAR1  507 WANKANE1   -13.674    6.883  0.3722  -7.1938     23.7&
163  507 WANKANE1  529 JAMNAGA1    -4.477   -5.184  0.0210  -4.9994      8.2&
164  529 JAMNAGA1  509   SIKKA1   -30.645   -4.653  0.3239  -1.3800     37.1^
165  529 JAMNAGA1  508 NAGHEDI1   -19.879   -1.897  0.0273  -0.3904     23.8&
166  530 JAMKHAM1  516  BHATIA1    55.223    8.556  0.9177   0.9530     66.5$
167  509   SIKKA1  530 JAMKHAM1    71.843   17.337  1.6210   2.7807     88.0#
168  142 ICHHAPU2  108 VALTHAN2   181.299   18.750  2.0744   4.9569    182.3!
169  140 DHRANGA2  161   MORVI2    80.476   25.092  0.4734 -14.9201     21.5&
170   55    SOJA4   60   ZERDA4   151.790 -102.286  0.6871 -67.8615     22.2&
171   19     SSP4   51    ASOJ4    32.001    7.981  0.0296 -91.3714      6.3&
172  130 GANDHIN2  159   JAMLA2   182.520  -14.685  0.5598  -3.0877     44.0^
173  159   JAMLA2  131    SOJA2   136.961  -14.604  0.0910  -1.2114     33.1^
174  167 KHANPUR2  145 KAPADWA2   -24.388    5.430  0.0254 -12.8166      7.3&
175  120 KARAMSA2  157 SALEJAD2   136.385   10.794  2.1847   0.9285     65.8$
176  157 SALEJAD2  168 CHORANI2    84.200  -13.139  0.8671  -5.4211     41.0^
177  106 NAVSARI2  170 CHIKHLI2   105.072   40.675  0.5345  -0.5521     54.2$
178  170 CHIKHLI2  107    VAPI2    84.538   31.228  0.6593  -2.4939     43.5^
179  141 HALDARV2  172   WAGRA2    35.029   20.496  0.0277  -5.5037     10.5&
180  143   ZERDA2  171  THARAD2    30.044   -8.141  0.0439 -14.1423      7.5&
181   61    GTEC4   58  JHANOR4    63.805  135.591  0.0449  -5.2704     18.8&
182  141 HALDARV2  173    GTEC2   -18.330   49.837  0.0209  -2.4237     13.3&
183  173    GTEC2  120 KARAMSA2   316.286  -47.380  8.2672  12.2266     76.9#
-------------------------------------------------------------------------------
! NUMBER OF LINES LOADED BEYOND  125%          :    1
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% :    2
# NUMBER OF LINES LOADED BETWEEN  75% AND 100% :   11
$ NUMBER OF LINES LOADED BETWEEN  50% AND  75% :   41
^ NUMBER OF LINES LOADED BETWEEN  25% AND  50% :   63
& NUMBER OF LINES LOADED BETWEEN   1% AND  25% :   65
* NUMBER OF LINES LOADED BETWEEN   0% AND   1% :    0

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BUS WISE LINE FLOWS AND LINE LOSSES

FROM FROM       TO TO                FORWARD           LOSS
NODE NAME     NODE NAME            MW      MVAR      MW     MVAR
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   1 DHUVARAG  501 DHUVARA1   390.000   35.588    1.3556  27.1121
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2	SIKKAG	509	SIKKA1	195.000	53.613	0.8599	17.1971
3	UKAIHYDG	110	UKAIHYD2	154.000	29.678	0.3869	7.7383
4	UKAITHEG	109	UKAITHE2	613.806	38.277	2.5309	50.6186
5	WANAKBIG	116	WANAKBO2	504.000	27.897	2.4684	49.3684
6	WANAKBEG	52	WANAKBO4	522.000	206.462	3.0528	61.0552
7	GANDHING	130	GANDHIN2	615.000	94.991	2.4559	49.1192
8	PANANDRG	135	PANANDR2	190.000	24.767	0.7847	15.6937
9	KADANAG	117	KADANA2	200.000	9.000	0.8747	17.4936
10	JHANORG	155	JHANOR2	580.000	4.940	2.9737	59.4729
11	AECOMPDG	517	AECOMP1	390.000	91.332	1.9629	39.2591
12	INDORE4	51	ASOJ4	223.000	-157.262	1.3431	-305.4578
13	GIPCLG	528	GIPCL1	296.000	7.727	1.6419	32.8374
14	UTRANEG	146	UTRAN2	121.999	58.909	0.5729	11.4570
15	KAWASG	147	KAWAS2	625.000	113.820	3.5873	71.7476
16	KAKRAPAG	148	KAKRAPA2	390.000	97.086	1.8633	37.2659
17	ESSARG	154	ESSAR2	310.000	83.588	0.8494	16.9881
18	GTEC-IG	173	GTEC2	400.000	67.002	1.2818	25.6353
19	SSP4	51	ASOJ4	32.001	7.981	0.0296	-91.3714
51	ASOJ4	113	ASOJ2	-118.125	156.368	0.2132	4.2648
51	ASOJ4	54	UKAITHE4	-185.662	-7.187	0.9297	-65.2404
51	ASOJ4	53	JETPUR4	273.507	-19.773	4.6324	-111.9780
51	ASOJ4	52	WANAKBO4	-133.436	-90.727	0.3218	-37.6734
51	ASOJ4	57	CHORANI4	236.040	6.832	1.8285	-68.1565
51	ASOJ4	56	KASOR4	181.312	52.014	0.4575	-30.1747
51	ASOJ4	12	INDORE4	-221.657	-148.195	1.3431	-305.4578
51	ASOJ4	19	SSP4	-31.971	-99.352	0.0296	-91.3714
52	WANAKBO4	6	WANAKBEG	-518.947	-145.407	3.0528	61.0552
52	WANAKBO4	116	WANAKBO2	-44.002	57.341	0.0985	1.9694
52	WANAKBO4	51	ASOJ4	133.757	53.054	0.3218	-37.6734
52	WANAKBO4	55	SOJA4	429.192	35.010	1.7027	-89.2676
53	JETPUR4	124	JETPUR2	552.763	101.434	1.9133	38.2655
53	JETPUR4	51	ASOJ4	-268.875	-92.205	4.6324	-111.9780
53	JETPUR4	57	CHORANI4	-283.907	-59.282	2.6760	-52.7772
54	UKAITHE4	109	UKAITHE2	-186.587	58.048	0.6410	12.8196
54	UKAITHE4	51	ASOJ4	186.592	-58.053	0.9297	-65.2404
55	SOJA4	131	SOJA2	275.697	226.556	0.7286	14.5720
55	SOJA4	52	WANAKBO4	-427.489	-124.278	1.7027	-89.2676
55	SOJA4	60	ZERDA4	151.790	-102.286	0.6871	-67.8615

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56   KASOR4   169    KASOR2  -85.029    76.177    0.1117   2.2336
56   KASOR4    57  CHORANI4  265.886     6.014    1.4092 -37.7309
56   KASOR4    51     ASOJ4 -180.854   -82.189    0.4575 -30.1747

57 CHORANI4   168  CHORANI2  212.106   112.210    0.6904  13.8084
57 CHORANI4    51     ASOJ4 -234.211   -74.989    1.8285 -68.1565
57 CHORANI4    56    KASOR4 -264.477   -43.745    1.4092 -37.7309
57 CHORANI4    53   JETPUR4  286.583     6.505    2.6760 -52.7772

58  JHANOR4   155   JHANOR2 -236.742   252.029    0.6594  13.1884
58  JHANOR4    59   DEHGAM4  300.502  -111.172    1.8479 -234.7540
58  JHANOR4    61     GTEC4  -63.760  -140.862    0.0449  -5.2704

59  DEHGAM4   166   DEHGAM2  298.651   123.576    0.8546  17.0912
59  DEHGAM4    58   JHANOR4 -298.654  -123.582    1.8479 -234.7540

60   ZERDA4   143    ZERDA2  151.104   -34.424    0.2514   5.0289
60   ZERDA4    55     SOJA4 -151.103    34.424    0.6871 -67.8615

61    GTEC4   173     GTEC2  -63.809  -135.593    0.2707   5.4139
61    GTEC4    58   JHANOR4   63.805   135.591    0.0449  -5.2704

101   NASIK2  106 NAVSARI2 -180.003    -0.012    4.6056 -22.6547

103 WAGODIA2  112 JAMBUVA2  -74.568     3.200    0.2199  -2.7405
103 WAGODIA2  113    ASOJ2   24.568   -43.202    0.1090  -4.2193

104 SARDGAD2  124  JETPUR2  -57.455     8.646    0.3824  -6.6457
104 SARDGAD2  125  KESHOD2   32.454    -7.648    0.0909  -6.1209

105 TARAPUR2  106 NAVSARI2  -59.822   -13.826    0.9518 -14.5844
105 TARAPUR2  107    VAPI2  -30.180    13.822    0.1784  -9.0995

106 NAVSARI2  105 TARAPUR2   60.774    -0.758    0.9518 -14.5844
106 NAVSARI2  101   NASIK2  184.609   -22.643    4.6056 -22.6547
106 NAVSARI2  108 VALTHAN2 -210.750   -57.224    1.2715  -2.1954
106 NAVSARI2  147   KAWAS2 -429.702   -52.053    7.2104  23.7223
106 NAVSARI2  170 CHIKHLI2  105.072    40.675    0.5345  -0.5521

107    VAPI2  105 TARAPUR2   30.358   -22.921    0.1784  -9.0995
107    VAPI2  148 KAKRAPA2 -226.479   -70.371    5.7892  -2.0708
107    VAPI2  170 CHIKHLI2  -83.879   -33.722    0.6593  -2.4939

108 VALTHAN2  106 NAVSARI2  212.022    55.029    1.2715  -2.1954
108 VALTHAN2  109 UKAITHE2 -101.043   -83.989    0.8037 -13.1662
108 VALTHAN2  148 KAKRAPA2 -177.226   -36.906    1.1218  -5.9255
108 VALTHAN2  147   KAWAS2 -182.276   -12.953    1.9796   4.9320
108 VALTHAN2  144     KIM2   44.718     9.455    0.0734  -2.4727
108 VALTHAN2  112 JAMBUVA2   58.035   -35.844    0.7886 -12.0800
108 VALTHAN2  142 ICHHAPU2 -179.225   -13.793    2.0744   4.9569

109 UKAITHE2    4 UKAITHEG -611.275    12.342    2.5309  50.6186
109 UKAITHE2   54 UKAITHE4  187.228   -45.229    0.6410  12.8196
109 UKAITHE2  108 VALTHAN2  101.846    70.823    0.8037 -13.1662
109 UKAITHE2  111 ACHHALI2  264.007   -24.102    2.8265 -22.2679
109 UKAITHE2  110 UKAIHYD2   58.188   -13.827    0.0167  -1.6984

110 UKAIHYD2    3 UKAIHYDG -153.613   -21.940    0.3869   7.7383
110 UKAIHYD2  109 UKAITHE2  -58.172    12.128    0.0167  -1.6984
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110	UKAIHYD2	111	ACHHALI2	171.783	-15.193	1.7807	-15.3639
111	ACHHALI2	527	ACHHALI1	25.724	-9.228	0.0111	0.2228
111	ACHHALI2	109	UKAITHE2	-261.180	1.834	2.8265	-22.2679
111	ACHHALI2	110	UKAIHYD2	-170.002	-0.171	1.7807	-15.3639
111	ACHHALI2	112	JAMBUVA2	245.456	-66.447	1.0863	-22.0688
112	JAMBUVA2	519	JAMBUVA1	70.481	10.088	0.1132	2.2639
112	JAMBUVA2	141	HALDARV2	-147.916	23.886	2.7607	3.0487
112	JAMBUVA2	108	VALTHAN2	-57.246	23.764	0.7886	-12.0800
112	JAMBUVA2	111	ACHHALI2	-244.370	44.378	1.0863	-22.0688
112	JAMBUVA2	113	ASOJ2	115.826	-59.956	0.5942	-0.4230
112	JAMBUVA2	103	WAGODIA2	74.788	-5.940	0.2199	-2.7405
112	JAMBUVA2	120	KARAMSA2	188.433	-36.230	1.4252	-6.8157
113	ASOJ2	51	ASOJ4	118.338	-152.103	0.2132	4.2648
113	ASOJ2	521	ASOJ1	3.897	42.114	0.0252	0.5042
113	ASOJ2	112	JAMBUVA2	-115.232	59.533	0.5942	-0.4230
113	ASOJ2	103	WAGODIA2	-24.459	38.982	0.1090	-4.2193
113	ASOJ2	120	KARAMSA2	91.979	23.471	0.3002	-11.5814
113	ASOJ2	116	WANAKBO2	-79.509	-23.374	0.3965	-20.4627
113	ASOJ2	114	CHANDRA2	4.981	11.365	0.0068	-9.6207
114	CHANDRA2	115	GODHRA2	-55.026	-0.019	0.0781	-10.1145
114	CHANDRA2	113	ASOJ2	-4.974	-20.985	0.0068	-9.6207
115	GODHRA2	116	WANAKBO2	-63.390	-26.891	0.2529	-3.7556
115	GODHRA2	117	KADANA2	-81.713	-18.014	0.4192	-20.8324
115	GODHRA2	114	CHANDRA2	55.104	-10.095	0.0781	-10.1145
116	WANAKBO2	5	WANAKBIG	-501.532	21.472	2.4684	49.3684
116	WANAKBO2	52	WANAKBO4	44.101	-55.372	0.0985	1.9694
116	WANAKBO2	113	ASOJ2	79.906	2.911	0.3965	-20.4627
116	WANAKBO2	115	GODHRA2	63.643	23.135	0.2529	-3.7556
116	WANAKBO2	118	DHANSUR2	111.512	15.552	0.6029	-14.2265
116	WANAKBO2	119	RANASAN2	91.176	-0.068	0.9967	-6.1686
116	WANAKBO2	145	KAPADWA2	111.192	-7.634	0.7226	-1.8589
117	KADANA2	9	KADANAG	-199.125	8.494	0.8747	17.4936
117	KADANA2	115	GODHRA2	82.132	-2.818	0.4192	-20.8324
117	KADANA2	118	DHANSUR2	116.993	-5.676	0.7917	-17.5024
118	DHANSUR2	116	WANAKBO2	-110.909	-29.779	0.6029	-14.2265
118	DHANSUR2	117	KADANA2	-116.202	-11.826	0.7917	-17.5024
118	DHANSUR2	139	HIMATNA2	167.111	8.605	1.4586	2.6202
119	RANASAN2	504	RANASAN1	239.047	95.463	0.5289	10.5777
119	RANASAN2	116	WANAKBO2	-90.180	-6.100	0.9967	-6.1686
119	RANASAN2	145	KAPADWA2	-55.797	-12.519	0.2578	-6.0474
119	RANASAN2	120	KARAMSA2	-55.624	15.063	0.1922	-19.8596
119	RANASAN2	130	GANDHIN2	223.573	-2.738	0.7598	-2.1076
119	RANASAN2	166	DEHGAM2	-261.020	-89.175	1.1491	0.1989
120	KARAMSA2	502	KARAMSA1	66.784	40.123	0.1377	2.7539
120	KARAMSA2	112	JAMBUVA2	-187.008	29.414	1.4252	-6.8157
120	KARAMSA2	113	ASOJ2	-91.679	-35.053	0.3002	-11.5814
120	KARAMSA2	119	RANASAN2	55.816	-34.923	0.1922	-19.8596
120	KARAMSA2	122	VARTEJ2	119.183	2.625	4.4809	-5.6304
120	KARAMSA2	169	KASOR2	208.536	-72.600	0.3703	-4.1361
120	KARAMSA2	157	SALEJAD2	136.385	10.794	2.1847	0.9285

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120 KARAMSA2  173     GTEC2  308.019    59.607   8.2672  12.2266

121   LIMDI2  510    LIMDI1   24.676    24.947   0.0249   0.4982
121   LIMDI2  123   GONDAL2  101.604    -7.189   2.4317  -7.8144
121   LIMDI2  168  CHORANI2 -126.277   -17.764   0.0328  -0.5957

122  VARTEJ2  120  KARAMSA2 -114.702    -8.255   4.4809  -5.6304
122  VARTEJ2  169    KASOR2 -118.558    -9.252   4.4684  -3.7809
122  VARTEJ2  127  SAVARKU2   93.258   -24.523   1.3906  -5.3463

123  GONDAL2  513   GONDAL1  119.069    44.003   0.3957   7.9144
123  GONDAL2  121    LIMDI2  -99.172    -0.626   2.4317  -7.8144
123  GONDAL2  163   RAJKOT2   47.711     8.464   0.2315  -5.8045
123  GONDAL2  124   JETPUR2  -67.611   -51.853   0.3206  -1.7672

124  JETPUR2   53   JETPUR4 -550.849   -63.168   1.9133  38.2655
124  JETPUR2  163   RAJKOT2   63.097    24.645   0.5731  -6.1058
124  JETPUR2  123   GONDAL2   67.932    50.085   0.3206  -1.7672
124  JETPUR2  138  RANAVAV2   54.450    -5.506   0.5273 -11.0425
124  JETPUR2  152  MOTIPAN2   51.142    -3.331   0.3316  -8.1328
124  JETPUR2  127  SAVARKU2   40.213     2.481   0.2624 -10.6292
124  JETPUR2  151  VISAVAD2   30.088    -8.805   0.0867  -6.8069
124  JETPUR2  165  JAMNAGA2   34.201    15.508   0.1246 -20.2074
124  JETPUR2  104  SARDGAD2   57.837   -15.292   0.3824  -6.6457
124  JETPUR2  125   KESHOD2   71.902   -16.616   0.6722  -6.4850

125  KESHOD2  104  SARDGAD2  -32.363     1.528   0.0909  -6.1209
125  KESHOD2  124   JETPUR2  -71.230    10.131   0.6722  -6.4850
125  KESHOD2  126  KODINAR2   33.590    -3.662   0.1247  -7.8899

126 KODINAR2  153  DHOKADV2  -26.536    10.225   0.0839  -6.7303
126 KODINAR2  125   KESHOD2  -33.466    -4.228   0.1247  -7.8899

127 SAVARKU2  124   JETPUR2  -39.950   -13.110   0.2624 -10.6292
127 SAVARKU2  122   VARTEJ2  -91.867    19.176   1.3906  -5.3463
127 SAVARKU2  153  DHOKADV2   41.814   -20.080   0.1928  -6.1263

128 VIRAMGA2  129  CHHATRA2 -134.479   -21.654   1.2429   0.8942
128 VIRAMGA2  168  CHORANI2   24.478   -19.353   0.0938  -8.5331

129 CHHATRA2  130  GANDHIN2 -355.721   -74.553   2.8586   6.7525
129 CHHATRA2  128  VIRAMGA2  135.722    22.548   1.2429   0.8942

130 GANDHIN2    7  GANDHING -612.544   -45.871   2.4559  49.1192
130 GANDHIN2  119  RANASAN2 -222.813     0.631   0.7598  -2.1076
130 GANDHIN2  131     SOJA2  294.259   -21.392   1.0809   0.9804
130 GANDHIN2  129  CHHATRA2  358.580    81.306   2.8586   6.7525
130 GANDHIN2  159    JAMLA2  182.520   -14.685   0.5598  -3.0877

131    SOJA2   55     SOJA4 -274.968  -211.984   0.7286  14.5720
131    SOJA2  130  GANDHIN2 -293.178    22.372   1.0809   0.9804
131    SOJA2  136  PALANPU2   65.428    28.311   0.8299  -8.6517
131    SOJA2  160  KHERALU2   65.347    22.743   0.5408  -6.5852
131    SOJA2  137  VIJAPUR2   24.795    18.669   0.0211  -6.6226
131    SOJA2  132  MEHSANA2  549.450   106.504   4.8509   3.0624
131    SOJA2  159    JAMLA2 -136.870    13.392   0.0910  -1.2114

132 MEHSANA2  131     SOJA2 -544.599  -103.442   4.8509   3.0624
132 MEHSANA2  134    ANJAR2   73.745   -29.043   2.3685 -27.5164
132 MEHSANA2  158  SANKHAR2  130.853    -9.536   1.7369  -0.1251
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133	DEODAR2	158	SANKHAR2	-77.375	19.029	1.7402	-14.3887
133	DEODAR2	134	ANJAR2	-7.626	-9.032	0.0204	-25.9882
134	ANJAR2	506	ANJAR1	51.389	22.153	0.0634	1.2687
134	ANJAR2	132	MEHSANA2	-71.376	1.527	2.3685	-27.5164
134	ANJAR2	133	DEODAR2	7.646	-16.956	0.0204	-25.9882
134	ANJAR2	135	PANANDR2	-87.662	-42.733	1.0426	-44.8595
135	PANANDR2	8	PANANDRG	-189.215	-9.073	0.7847	15.6937
135	PANANDR2	134	ANJAR2	88.705	-2.127	1.0426	-44.8595
135	PANANDR2	149	NAKHATR2	80.510	-1.802	0.3572	-20.7395
136	PALANPU2	131	SOJA2	-64.598	-36.963	0.8299	-8.6517
136	PALANPU2	160	KHERALU2	-34.644	-29.251	0.1624	-5.9226
136	PALANPU2	143	ZERDA2	-0.757	33.212	0.0503	-10.1024
137	VIJAPUR2	131	SOJA2	-24.774	-25.292	0.0211	-6.6226
137	VIJAPUR2	139	HIMATNA2	-85.226	16.291	0.4264	-2.7271
138	RANAVAV2	515	RANAVAV1	74.661	10.639	0.1384	2.7677
138	RANAVAV2	124	JETPUR2	-53.923	-5.536	0.5273	-11.0425
138	RANAVAV2	152	MOTIPAN2	-20.742	-5.110	0.0669	-11.3121
139	HIMATNA2	118	DHANSUR2	-165.653	-5.985	1.4586	2.6202
139	HIMATNA2	137	VIJAPUR2	85.653	-19.018	0.4264	-2.7271
140	DHRANGA2	168	CHORANI2	-190.476	-68.104	2.3468	-5.4052
140	DHRANGA2	161	MORVI2	80.476	25.092	0.4734	-14.9201
141	HALDARV2	148	KAKRAPA2	22.557	19.330	0.0791	-20.1248
141	HALDARV2	147	KAWAS2	-51.696	19.665	0.2313	-21.6515
141	HALDARV2	156	ZAGADIA2	99.863	37.149	0.7460	-1.9750
141	HALDARV2	112	JAMBUVA2	150.677	-20.837	2.7607	3.0487
141	HALDARV2	155	JHANOR2	-338.097	-180.637	1.5248	3.6706
141	HALDARV2	172	WAGRA2	35.029	20.496	0.0277	-5.5037
141	HALDARV2	173	GTEC2	-18.330	49.837	0.0209	-2.4237
142	ICHHAPU2	147	KAWAS2	51.719	9.320	0.0372	-0.9512
142	ICHHAPU2	154	ESSAR2	-308.017	-65.064	1.1358	1.5348
142	ICHHAPU2	108	VALTHAN2	181.299	18.750	2.0744	4.9569
143	ZERDA2	60	ZERDA4	-150.852	39.452	0.2514	5.0289
143	ZERDA2	136	PALANPU2	0.808	-43.314	0.0503	-10.1024
143	ZERDA2	171	THARAD2	30.044	-8.141	0.0439	-14.1423
144	KIM2	146	UTRAN2	-11.417	-0.999	0.0027	-6.5693
144	KIM2	108	VALTHAN2	-44.645	-11.927	0.0734	-2.4727
144	KIM2	156	ZAGADIA2	-68.937	-22.069	0.1806	-1.9440
145	KAPADWA2	116	WANAKBO2	-110.469	5.775	0.7226	-1.8589
145	KAPADWA2	119	RANASAN2	56.055	6.471	0.2578	-6.0474
145	KAPADWA2	167	KHANPUR2	24.413	-18.247	0.0254	-12.8166
146	UTRAN2	14	UTRANEG	-121.426	-47.452	0.5729	11.4570
146	UTRAN2	144	KIM2	11.420	-5.571	0.0027	-6.5693
147	KAWAS2	15	KAWASG	-621.413	-42.072	3.5873	71.7476
147	KAWAS2	106	NAVSARI2	436.912	75.775	7.2104	23.7223
147	KAWAS2	108	VALTHAN2	184.256	17.885	1.9796	4.9322

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147   KAWAS2  141 HALDARV2   51.928   41.317   0.2313 -21.6515
147   KAWAS2  142 ICHHAPU2  -51.682  -10.271   0.0372  -0.9512

148 KAKRAPA2   16 KAKRAPAG -388.137  -59.820   1.8633  37.2659
148 KAKRAPA2  108 VALTHAN2  178.348   30.980   1.1218  -5.9255
148 KAKRAPA2  141 HALDARV2  -22.478  -39.455   0.0791 -20.1248
148 KAKRAPA2  107    VAPI2  232.269   68.300   5.7892  -2.0708

149 NAKHATR2  135 PANANDR2  -80.153  -18.937   0.3572 -20.7395
149 NAKHATR2  150 NANIKHA2   50.153   17.937   0.1526 -16.0648

150 NANIKHA2  149 NAKHATR2  -50.000  -34.002   0.1526 -16.0648

151 VISAVAD2  124  JETPUR2  -30.001    1.999   0.0867  -6.8069

152 MOTIPAN2  124  JETPUR2  -50.810   -4.802   0.3316  -8.1328
152 MOTIPAN2  138 RANAVAV2   20.809   -6.202   0.0669 -11.3121

153 DHOKADV2  127 SAVARKU2  -41.621   13.953   0.1928  -6.1263
153 DHOKADV2  126 KODINAR2   26.620  -16.956   0.0839  -6.7303

154   ESSAR2   17   ESSARG -309.150  -66.600   0.8494  16.9881
154   ESSAR2  142 ICHHAPU2  309.153   66.599   1.1358   1.5348

155  JHANOR2   58  JHANOR4  237.401 -238.841   0.6594  13.1884
155  JHANOR2   10  JHANORG -577.027   54.533   2.9737  59.4729
155  JHANOR2  141 HALDARV2  339.622  184.308   1.5248   3.6706

156 ZAGADIA2  144     KIM2   69.118   20.125   0.1806  -1.9440
156 ZAGADIA2  141 HALDARV2  -99.117  -39.124   0.7460  -1.9750

157 SALEJAD2  120 KARAMSA2 -134.200   -9.866   2.1847   0.9285
157 SALEJAD2  168 CHORANI2   84.200  -13.139   0.8671  -5.4211

158 SANKHAR2  132 MEHSANA2 -129.117    9.411   1.7369  -0.1251
158 SANKHAR2  133  DEODAR2   79.116  -33.417   1.7402 -14.3887

159   JAMLA2  130 GANDHIN2 -181.960   11.597   0.5598  -3.0877
159   JAMLA2  131    SOJA2  136.961  -14.604   0.0910  -1.2114

160 KHERALU2  131    SOJA2  -64.807  -29.328   0.5408  -6.5852
160 KHERALU2  136 PALANPU2   34.807   23.328   0.1624  -5.9226

161   MORVI2  140 DHRANGA2  -80.002  -40.012   0.4734 -14.9201

163  RAJKOT2  123  GONDAL2  -47.479  -14.268   0.2315  -5.8045
163  RAJKOT2  124  JETPUR2  -62.524  -30.750   0.5731  -6.1058

165 JAMNAGA2  529 JAMNAGA1  -45.925   -4.298   0.1038   2.0763
165 JAMNAGA2  124  JETPUR2  -34.077  -35.716   0.1246 -20.2074

166  DEHGAM2   59  DEHGAM4 -297.796 -106.485   0.8546  17.0912
166  DEHGAM2  119 RANASAN2  262.169   89.374   1.1491   0.1989
166  DEHGAM2  167 KHANPUR2   35.627   17.113   0.0151  -3.3205

167 KHANPUR2  166  DEHGAM2  -35.612  -20.433   0.0151  -3.3205
167 KHANPUR2  145 KAPADWA2  -24.388    5.430   0.0254 -12.8166

168 CHORANI2   57 CHORANI4 -211.416  -98.402   0.6904  13.8084
168 CHORANI2  128 VIRAMGA2  -24.384   10.820   0.0938  -8.5331
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168 CHORANI2   140 DHRANGA2   192.823    62.698   2.3468  -5.4052
168 CHORANI2   121    LIMDI2  126.310    17.168   0.0328  -0.5957
168 CHORANI2   157 SALEJAD2   -83.333     7.718   0.8671  -5.4211

169   KASOR2    56    KASOR4   85.140   -73.943   0.1117   2.2336
169   KASOR2   120 KARAMSA2 -208.165    68.464   0.3703  -4.1361
169   KASOR2   122   VARTEJ2 123.026     5.471   4.4684  -3.7809

170 CHIKHLI2   106 NAVSARI2 -104.537   -41.227   0.5345  -0.5521
170 CHIKHLI2   107     VAPI2   84.538    31.228   0.6593  -2.4939

171   THARAD2  143    ZERDA2  -30.000    -6.001   0.0439 -14.1423

172    WAGRA2  141 HALDARV2  -35.001   -26.000   0.0277  -5.5037

173     GTEC2   18  GTEC-IG -398.719   -41.366   1.2818  25.6353
173     GTEC2   61     GTEC4   64.080   141.007   0.2707   5.4139
173     GTEC2  141 HALDARV2   18.351   -52.261   0.0209  -2.4237
173     GTEC2  120 KARAMSA2  316.286   -47.380   8.2672  12.2266

501 DHUVARA1     1 DHUVARAG -388.645    -8.476   1.3556  27.1121
501 DHUVARA1   518    GOTRI1  -12.458     2.604   0.0297  -4.9067
501 DHUVARA1   502 KARAMSA1   69.062     7.325   0.7092  -2.3044
501 DHUVARA1   503    VATWA1   85.408    -3.206   1.4034  -1.6085
501 DHUVARA1   510    LIMDI1  111.088   -10.095   5.0613   2.9580
501 DHUVARA1   511  DHANDHU1   80.592    14.963   4.8504   9.4047
501 DHUVARA1   514   RAJKOT1   54.955    -3.132   5.4033   3.4269

502 KARAMSA1   120 KARAMSA2  -66.646   -37.369   0.1377   2.7539
502 KARAMSA1   501 DHUVARA1  -68.352    -9.630   0.7092  -2.3044

503   VATWA1   501 DHUVARA1  -84.004     1.598   1.4034  -1.6085
503   VATWA1   504 RANASAN1    4.003   -31.598   0.0891  -2.4988

504 RANASAN1   119 RANASAN2 -238.518   -84.885   0.5289  10.5777
504 RANASAN1   503    VATWA1   -3.914    29.100   0.0891  -2.4988
504 RANASAN1   505 SABARMA1   62.437    70.793   0.4206  -0.1341

505 SABARMA1   517   AECOMP1   62.013    70.960   0.0085  -0.0247
505 SABARMA1   504 RANASAN1  -62.016   -70.927   0.4206  -0.1341

506   ANJAR1   134    ANJAR2  -51.326   -20.884   0.0634   1.2687
506   ANJAR1   507 WANKANE1  -13.674     6.883   0.3722  -7.1938

507 WANKANE1   510    LIMDI1  -68.838    13.571   1.8416  -4.0364
507 WANKANE1   508 NAGHEDI1   -5.735    -5.318   0.0333  -5.4381
507 WANKANE1   506    ANJAR1   14.046   -14.076   0.3722  -7.1938
507 WANKANE1   529 JAMNAGA1   -4.477    -5.184   0.0210  -4.9994

508 NAGHEDI1   509    SIKKA1  -70.676   -10.389   0.6501  -1.5985
508 NAGHEDI1   507 WANKANE1    5.768    -0.120   0.0333  -5.4381
508 NAGHEDI1   529 JAMNAGA1   19.907     1.507   0.0273  -0.3904

509   SIKKA1     2    SIKKAG -194.140   -36.416   0.8599  17.1971
509   SIKKA1   508 NAGHEDI1   71.326     8.791   0.6501  -1.5985
509   SIKKA1   529 JAMNAGA1   30.969     3.273   0.3239  -1.3800
509   SIKKA1   530 JAMKHAM1   71.843    17.337   1.6210   2.7807

510   LIMDI1   121    LIMDI2  -24.651   -24.449   0.0249   0.4982
510   LIMDI1   501 DHUVARA1 -106.027    13.053   5.0613   2.9580
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510	LIMDI1	507	WANKANE1	70.679	17.607	1.8416	-4.0364
511	DHANDHU1	501	DHUVARA1	-75.742	-5.558	4.8504	9.4047
511	DHANDHU1	512	PALIAD1	55.745	-9.446	1.6325	2.0806
512	PALIAD1	511	DHANDHU1	-54.113	11.526	1.6325	2.0806
512	PALIAD1	513	GONDAL1	19.108	-22.536	0.5934	-2.2684
513	GONDAL1	123	GONDAL2	-118.674	-36.088	0.3957	7.9144
513	GONDAL1	512	PALIAD1	-18.515	20.268	0.5934	-2.2684
513	GONDAL1	514	RAJKOT1	-4.485	13.003	0.0638	-1.5675
513	GONDAL1	515	RANAVAV1	1.669	-10.196	0.0564	-6.9191
514	RAJKOT1	501	DHUVARA1	-49.552	6.559	5.4033	3.4269
514	RAJKOT1	513	GONDAL1	4.549	-14.570	0.0638	-1.5675
515	RANAVAV1	138	RANAVAV2	-74.523	-7.871	0.1384	2.7677
515	RANAVAV1	513	GONDAL1	-1.612	3.277	0.0564	-6.9191
515	RANAVAV1	516	BHATIA1	-13.866	19.595	0.4382	-2.8094
516	BHATIA1	515	RANAVAV1	14.304	-22.404	0.4382	-2.8094
516	BHATIA1	530	JAMKHAM1	-54.305	-7.603	0.9177	0.9530
517	AECOMP1	11	AECOMPDG	-388.037	-52.073	1.9629	39.2591
517	AECOMP1	505	SABARMA1	-62.005	-70.985	0.0085	-0.0247
518	GOTRI1	520	FERTNGR1	-82.466	34.538	0.2292	-0.1877
518	GOTRI1	519	JAMBUVA1	-30.022	-20.027	0.0125	-3.7206
518	GOTRI1	501	DHUVARA1	12.488	-7.511	0.0297	-4.9067
519	JAMBUVA1	112	JAMBUVA2	-70.368	-7.824	0.1132	2.2639
519	JAMBUVA1	524	MIYAGAM1	-25.318	2.338	0.1388	-1.2250
519	JAMBUVA1	523	JAWAHAR1	-34.350	13.186	0.1855	-3.4896
519	JAMBUVA1	518	GOTRI1	30.034	16.306	0.0125	-3.7206
520	FERTNGR1	523	JAWAHAR1	-108.654	30.537	0.3178	0.1608
520	FERTNGR1	518	GOTRI1	82.695	-34.726	0.2292	-0.1877
520	FERTNGR1	521	ASOJ1	-9.041	-17.809	0.0160	-1.2565
521	ASOJ1	113	ASOJ2	-3.872	-41.610	0.0252	0.5042
521	ASOJ1	522	NANDESA1	-65.185	28.056	0.3461	-1.0654
521	ASOJ1	520	FERTNGR1	9.057	16.553	0.0160	-1.2565
522	NANDESA1	521	ASOJ1	65.531	-29.121	0.3461	-1.0654
522	NANDESA1	528	GIPCL1	-100.533	7.111	0.0140	-0.4858
523	JAWAHAR1	519	JAMBUVA1	34.535	-16.675	0.1855	-3.4896
523	JAWAHAR1	528	GIPCL1	-193.504	16.047	0.2957	-1.4671
523	JAWAHAR1	520	FERTNGR1	108.972	-30.376	0.3178	0.1608
524	MIYAGAM1	519	JAMBUVA1	25.457	-3.563	0.1388	-1.2250
524	MIYAGAM1	525	BHARUCH1	-25.457	3.563	0.1462	-1.2799
525	BHARUCH1	524	MIYAGAM1	25.603	-4.843	0.1462	-1.2799
525	BHARUCH1	526	ANKLESH1	-25.603	4.840	0.0242	-1.0310
526	ANKLESH1	527	ACHHALI1	-25.627	5.870	0.0878	-3.5768
526	ANKLESH1	525	BHARUCH1	25.627	-5.871	0.0242	-1.0310
527	ACHHALI1	111	ACHHALI2	-25.713	9.450	0.0111	0.222

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527 ACHHALI1   526 ANKLESH1     25.714    -9.447    0.0878   -3.5768

528   GIPCL1    13   GIPCLG   -294.358    25.110    1.6419   32.8374
528   GIPCL1   523 JAWAHAR1    193.800   -17.514    0.2957   -1.4671
528   GIPCL1   522 NANDESA1    100.548    -7.597    0.0140   -0.4858

529 JAMNAGA1   165 JAMNAGA2     46.029     6.375    0.1038    2.0763
529 JAMNAGA1   507 WANKANE1      4.498     0.185    0.0210   -4.9994
529 JAMNAGA1   509   SIKKA1     30.645    -4.653    0.3239   -1.3800
529 JAMNAGA1   508 NAGHEDI1    -19.879    -1.897    0.0273   -0.3904

530 JAMKHAM1   516  BHATIA1     55.223     8.556    0.9177    0.9530
530 JAMKHAM1   509   SIKKA1    -70.222   -14.557    1.6210    2.7807
-----------------------------------------------------------------------------      --------
EW SYSTEM FREQUENCY FOR ISLAND 1              :        50.000 Hzs

TOTAL REAL POWER GENERATION     :    6751.805 MW
TOTAL REACT. POWER GENERATION :       995.390 MVAR

TOTAL SHUNT REACTOR INJECTION :        -0.000 MW
TOTAL SHUNT REACTOR INJECTION :        -0.000 MVAR

TOTAL SHUNT CAPACIT.INJECTION :        -0.000 MW
TOTAL SHUNT CAPACIT.INJECTION :        -0.000 MVAR

TOTAL REAL POWER LOAD           :    6564.999 MW
TOTAL REACTIVE POWER LOAD       :    4766.999 MVAR
TOTAL COMPENSATION AT LOADS     :    2570.000 MW
TOTAL HVDC REACTIVE POWER       :       0.000 MVAR

TOTAL REAL POWER LOSS (AC+DC)  :      186.700 MW (    186.700+       0.000)
PERCENTAGE REAL  LOSS (AC+DC)  :        2.765
TOTAL REACTIVE POWER  LOSS     :   -1202.158 MVAR

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Zone wise distribution
Description          Zone # 1    Zone # 2    Zone # 3    Zone # 4    Zone # 5

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MW generation        3194.8055   2166.9998   1005.0000    195.0000    190.0000

VAR generation        493.2966    237.3905    186.3230     53.6128     24.7669

MW load
                     1860.0000    935.0000   2010.0002   1494.9999    265.0000

MVAR load
                     1072.0000    675.9999   1586.0001   1208.0002    225.0000

MVAR compensation     400.0000    148.0000   1101.9999    792.9999    127.0000

MW loss
                       67.3294     62.8471     27.9810     25.7695      2.7727

MVAR loss
                     -153.0496   -752.6160    -72.8657   -151.7312    -71.8951

MVAR - inductive        0.0000      0.0000      0.0000      0.0000      0.0000

MVAR - capacitive       0.0000      0.0000      0.0000      0.0000      0.0000

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Zone wise export(+ve)/import(-ve)
Zone #    1 MW & MVAR           2 MW & MVAR          3 MW & MVAR          4 MW & MVAR
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      5 MW & MVAR
 ------ -------- -------- -------- -------- -------- -------- -------- --------
   1       -----           1267.47   -25.71     0.00     0.00     0.00     0.00
        0.00     0.00

   2 -1267.47    25.71       -----            1121.13   229.51  1315.48   206.67
        0.00     0.00

   3    0.00     0.00 -1121.13  -229.51      -----               24.38   -10.82
       63.73    15.43

   4    0.00     0.00 -1315.48  -206.67   -24.38    10.82      -----
       14.05   -14.08

   5    0.00     0.00     0.00     0.00   -63.73   -15.43   -14.05    14.08
          -----

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ate and Time : Fri Oct 17 17:21:20 1997
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	2001-2002	
9FYPP.xls		
	The Projects Considered are :	
1	Reliance Power Limited (Motikhavdi)	250 MW
2	Coal based (Coastal)	500 MW
	Power Plant (Rampura)	
3	Gandhar CCPP (GTEC) Stage-II	655 MW
4	CEPA Share at Dehgam	700 MW

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Date and Time : Thu Dec  4 14:34:44 1997
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RESULTS OF LOAD FLOW ANALYSIS :
Contingency : BASE CASE              .          2001-2002
Schedule    : SCHEDULE 0                  .

-------------------------------------------------------------------------------
LARGEST BUS NUMBER USED          :  530    ACTUAL NUMBER OF BUSES           :  165
NUMBER OF 2 WIND. TRANSFORMERS   :   48    NUMBER OF 3 WIND. TRANSFORMERS   :    0
NUMBER OF TRANSMISSION LINES     :  203
NUMBER OF SERIES REACTORS        :    0    NUMBER OF SERIES CAPACITORS      :    0
NUMBER OF CIRCUIT BREAKERS       :    0
NUMBER OF SHUNT REACTORS         :    0    NUMBER OF SHUNT CAPACITORS       :    0
NUMBER OF SHUNT IMPEDANCES       :    0
NUMBER OF GENERATORS             :   26    NUMBER OF LOADS                  :   95
NUMBER OF LOAD CHARACTERISTICS   :    0    NUMBER OF UNDER FREQUENCY RELAY:     0
NUMBER OF GEN CAPABILITY CURVES:      0    NUMBER OF FILTERS                :    0
NUMBER OF TIE LINE SCHEDULES     :    0
NUMBER OF CONVERTORS             :    0    NUMBER OF DC LINKS               :    0

-------------------------------------------------------------------------------
ONLY LOAD FLOW - OPTION                                 :    0
NUMBER OF ZONES                                         :    5
PRINT OPTION                                            :    5 - BUS WISE FLOW PRINT
PLOT OPTION                                             :    1 - PLOTTING WITH PU VOLTA
NO FREQUENCY DEPENDENT LOAD FLOW, CONTROL OPTION:    0
BASE MVA                                                : 100.000000
NOMINAL SYSTEM FREQUENCY (Hzs)                          : 50.000000
FREQUENCY DEVIATION (Hzs)                               : 0.000000
FLOWS IN MW AND MVAR, OPTION                            : 0
SLACK BUS                                               :    7
TRANSFORMER TAP CONTROL OPTION                          :    0
Q CHECKING LIMIT  (ENABLED)                             :    4
REAL POWER TOLERANCE (PU)                               :  0.00100
REACTIVE POWER TOLERANCE (PU)                           :  0.00100
MAXIMUM NUMBER OF ITERATIONS                            :   15
BUS VOLTAGE BELOW WHICH LOAD MODEL IS CHANGED           :  0.75000
CIRCUIT BREAKER RESISTANCE  (PU)                        :  0.00000
CIRCUIT BREAKER REACTANCE   (PU)                        :  0.00010
TRANSFORMER R/X RATIO                                   :  0.05000
-------------------------------------------------------------------------------
ANNUAL PERCENTAGE INTEREST CHARGES                      :  15.000
ANNUAL PERCENT OPERATION & MAINTENANCE CHARGES          :   3.000
LIFE OF EQUIPMENT IN YEARS                              :  20.000
ENERGY UNIT CHARGE (KWHOUR) IN RUPEES                   :   0.650
LOSS LOAD FACTOR                                        :   0.300
COST PER MVAR IN LAKHS OF RUPEES                        :   3.000
-------------------------------------------------------------------------------
ZONE WISE MULTIPLICATION FACTORS
ZONE    P LOAD    Q LOAD     P GEN     Q GEN  SH REACT    SH CAP
 --    -------   -------   -------   -------   -------   -------
  0     0.000     0.000     0.000     0.000     0.000     0.000
  1     1.000     1.000     1.000     1.000     1.000     1.000
  2     1.000     1.000     1.000     1.000     1.000     1.000
  3     1.000     1.000     1.000     1.000     1.000     1.000
  4     1.000     1.000     1.000     1.000     1.000     1.000
  5     1.000     1.000     1.000     1.000     1.000     1.000
-------------------------------------------------------------------
BUS DATA
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US NO. STATUS  ZONE    BUS  KV   VMIN-PU   VMAX-PU      NAME
------ ------  ----  --------   --------  --------  --------
     1      1     2    15.000      0.950     1.050 DHUVARAG
     2      1     4    13.800      0.950     1.050   SIKKAG
     3      1     1    11.000      0.950     1.050 UKAIHYDG
     4      1     1    15.750      0.950     1.050 UKAITHEG
     5      1     2    15.750      0.950     1.050 WANAKBIG
     6      1     2    15.750      0.950     1.050 WANAKBEG
     7      1     3    15.750      0.950     1.050 GANDHING
     8      1     5    11.000      0.950     1.050 PANANDRG
     9      1     2    11.000      0.950     1.050  KADANAG
    10      1     1    15.750      0.950     1.050  JHANORG
    11      1     3    11.000      0.950     1.050 AECOMPDG
    12      1     2   400.000      0.950     1.050  INDORE4
    13      1     2    11.000      0.950     1.050   GIPCLG
    14      1     1    11.000      0.950     1.050  UTRANEG
    15      1     1    11.500      0.950     1.050   KAWASG
    16      1     1    16.500      0.950     1.050 KAKRAPAG
    17      1     1    15.000      0.950     1.050   ESSARG
    18      1     1    15.750      0.950     1.050  GTEC-IG
    19      1     2   400.000      0.950     1.050     SSP4
    20      1     1    13.800      0.950     1.050 MANGROLG
    21      1     4    13.800      0.950     1.050  GHOGHAG
    23      1     5    13.800      0.950     1.050 AKRIMOTG
    24      1     4    15.750      0.950     1.050 MOTIKHAG
    25      1     4    15.750      0.950     1.050 RAMPURAG
    26      1     1    15.750      0.950     1.050 GTEC-IIG
    27      1     2    15.750      0.950     1.050  DEHGAMG
    51      1     2   400.000      0.950     1.050    ASOJ4
    52      1     2   400.000      0.950     1.050 WANAKBO4
    53      1     4   400.000      0.950     1.050  JETPUR4
    54      1     1   400.000      0.950     1.050 UKAITHE4
    55      1     3   400.000      0.950     1.050    SOJA4
    56      1     2   400.000      0.950     1.050   KASOR4
    57      1     4   400.000      0.950     1.050 CHORANI4
    58      1     1   400.000      0.950     1.050  JHANOR4
    59      1     2   400.000      0.950     1.050  DEHGAM4
    60      1     3   400.000      0.950     1.050   ZERDA4
    61      1     1   400.000      0.950     1.050    GTEC4
    62      1     4   400.000      0.950     1.050  AMRELI4
    63      1     4   400.000      0.950     1.050  RAJKOT4
    64      1     3   400.000      0.950     1.050 RANCHHO4
    65      1     4   400.000      0.950     1.050 RAMPURA4
    66      1     1   400.000      0.950     1.050  PADGHE4
   101      1     1   220.000      0.950     1.050   NASIK2
   102      1     4   220.000      0.950     1.050 PALITAN2
   103      1     2   220.000      0.950     1.050 WAGODIA2
   104      1     4   220.000      0.950     1.050 SARDGAD2
   105      1     1   220.000      0.950     1.050 TARAPUR2
   106      1     1   220.000      0.950     1.050 NAVSARI2
   107      1     1   220.000      0.950     1.050    VAPI2
   108      1     1   220.000      0.950     1.050 VALTHAN2
   109      1     1   220.000      0.950     1.050 UKAITHE2
   110      1     1   220.000      0.950     1.050 UKAIHYD2
   111      1     1   220.000      0.950     1.050 ACHHALI2
   112      1     2   220.000      0.950     1.050 JAMBUVA2
   113      1     2   220.000      0.950     1.050    ASOJ2
   114      1     2   220.000      0.950     1.050 CHANDRA2
   115      1     2   220.000      0.950     1.050  GODHRA2
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116	1	2	220.000	0.950	1.050	WANAKBO2
117	1	2	220.000	0.950	1.050	KADANA2
118	1	3	220.000	0.950	1.050	DHANSUR2
119	1	3	220.000	0.950	1.050	RANASAN2
120	1	2	220.000	0.950	1.050	KARAMSA2
121	1	4	220.000	0.950	1.050	LIMDI2
122	1	4	220.000	0.950	1.050	VARTEJ2
123	1	4	220.000	0.950	1.050	GONDAL2
124	1	4	220.000	0.950	1.050	JETPUR2
125	1	4	220.000	0.950	1.050	KESHOD2
126	1	4	220.000	0.950	1.050	KODINAR2
127	1	4	220.000	0.950	1.050	SAVARKU2
128	1	3	220.000	0.950	1.050	VIRAMGA2
129	1	3	220.000	0.950	1.050	CHHATRA2
130	1	3	220.000	0.950	1.050	GANDHIN2
131	1	3	220.000	0.950	1.050	SOJA2
132	1	3	220.000	0.950	1.050	MEHSANA2
133	1	3	220.000	0.950	1.050	DEODAR2
134	1	5	220.000	0.950	1.050	ANJAR2
135	1	5	220.000	0.950	1.050	PANANDR2
136	1	3	220.000	0.950	1.050	PALANPU2
137	1	3	220.000	0.950	1.050	VIJAPUR2
138	1	4	220.000	0.950	1.050	RANAVAV2
139	1	3	220.000	0.950	1.050	HIMATNA2
140	1	4	220.000	0.950	1.050	DHRANGA2
141	1	1	220.000	0.950	1.050	HALDARV2
142	1	1	220.000	0.950	1.050	ICHHAPU2
143	1	3	220.000	0.950	1.050	ZERDA2
144	1	1	220.000	0.950	1.050	KIM2
145	1	2	220.000	0.950	1.050	KAPADWA2
146	1	1	220.000	0.950	1.050	UTRAN2
147	1	1	220.000	0.950	1.050	KAWAS2
148	1	1	220.000	0.950	1.050	KAKRAPA2
149	1	5	220.000	0.950	1.050	NAKHATR2
150	1	5	220.000	0.950	1.050	NANIKHA2
151	1	4	220.000	0.950	1.050	VISAVAD2
152	1	4	220.000	0.950	1.050	MOTIPAN2
153	1	4	220.000	0.950	1.050	DHOKADV2
154	1	1	220.000	0.950	1.050	ESSAR2
155	1	1	220.000	0.950	1.050	JHANOR2
156	1	1	220.000	0.950	1.050	ZAGADIA2
157	1	2	220.000	0.950	1.050	SALEJAD2
158	1	3	220.000	0.950	1.050	SANKHAR2
159	1	3	220.000	0.950	1.050	JAMLA2
160	1	3	220.000	0.950	1.050	KHERALU2
161	1	4	220.000	0.950	1.050	MORBI2
162	1	4	220.000	0.950	1.050	AMRELI2
163	1	4	220.000	0.950	1.050	RAJKOT2
164	1	1	220.000	0.950	1.050	SACHIN2
165	1	4	220.000	0.950	1.050	JAMNAGA2
166	1	2	220.000	0.950	1.050	DEHGAM2
167	1	2	220.000	0.950	1.050	KHANPUR2
168	1	4	220.000	0.950	1.050	CHORANI2
169	1	2	220.000	0.950	1.050	KASOR2
170	1	1	220.000	0.950	1.050	CHIKHLI2
171	1	3	220.000	0.950	1.050	THARAD2
172	1	1	220.000	0.950	1.050	WAGRA2
173	1	1	220.000	0.950	1.050	GTEC2
174	1	1	220.000	0.950	1.050	MOBHA2
175	1	3	220.000	0.950	1.050	JOTANA2

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  1    4   220.000      0.950      1.050    DHASA2
  1    4   220.000      0.950      1.050  CHOTILA2
  1    1   220.000      0.950      1.050  MANGROL2
  1    3   220.000      0.950      1.050  SANTHAL2
  1    4   220.000      0.950      1.050  RAJKO-II
  1    4   220.000      0.950      1.050   MAHUVA2
  1    1   220.000      0.950      1.050  BARDOLI2
  1    3   220.000      0.950      1.050  JANGRAL2
  1    4   220.000      0.950      1.050   GHOGHA2
  1    1   220.000      0.950      1.050   BHILAD2
  1    3   220.000      0.950      1.050  RANCHHO2
  1    1   220.000      0.950      1.050    OLPAD2
  1    3   220.000      0.950      1.050  RADHANP2
  1    3   220.000      0.950      1.050  CHITROD2
  1    5   220.000      0.950      1.050  AKRIMOT2
  1    4   220.000      0.950      1.050  MOTIKHA2
  1    3   220.000      0.950      1.050  MATHASU2
  1    2   220.000      0.950      1.050  SEVALIA2
  1    2   132.000      0.950      1.050  DHUVARA1
  1    2   132.000      0.950      1.050  KARAMSA1
  1    2   132.000      0.950      1.050    VATWA1
  1    3   132.000      0.950      1.050  RANASAN1
  1    3   132.000      0.950      1.050  SABARMA1
  1    5   132.000      0.950      1.050    ANJAR1
  1    4   132.000      0.950      1.050  WANKANE1
  1    4   132.000      0.950      1.050  NAGHEDI1
  1    4   132.000      0.950      1.050    SIKKA1
  1    4   132.000      0.950      1.050    LIMDI1
  1    4   132.000      0.950      1.050  DHANDHU1
  1    4   132.000      0.950      1.050   PALIAD1
  1    4   132.000      0.950      1.050   GONDAL1
  1    4   132.000      0.950      1.050   RAJKOT1
  1    4   132.000      0.950      1.050  RANAVAV1
  1    4   132.000      0.950      1.050   BHATIA1
  1    3   132.000      0.950      1.050   AECOMP1
  1    2   132.000      0.950      1.050    GOTRI1
  1    2   132.000      0.950      1.050  JAMBUVA1
  1    2   132.000      0.950      1.050  FERTNGR1
  1    2   132.000      0.950      1.050     ASOJ1
  1    2   132.000      0.950      1.050  NANDESA1
  1    2   132.000      0.950      1.050  JAWAHAR1
  1    2   132.000      0.950      1.050  MIYAGAM1
  1    1   132.000      0.950      1.050  BHARUCH1
  1    1   132.000      0.950      1.050  ANKLESH1
  1    1   132.000      0.950      1.050  ACHHALI1
  1    2   132.000      0.950      1.050    GIPCL1
  1    4   132.000      0.950      1.050  JAMNAGA1
  1    4   132.000      0.950      1.050  JAMKHAM1
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R DATA

FROM FROM          TO  TO                  IMPEDANCE          NOMINAL    RATING
NODE NAME*       NODE NAME*          R(P.U)     X(P.U.)           TAP       MVA
                                     MINTAP      MAXTAP       TAPSTEP  SHIFT-DE
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 501 DHUVARA1     1 DHUVARAG     0.00088    0.01768    1.05000    710.00
                                 0.95000    1.05000    0.02500     0.000
 509    SIKKA1    2    SIKKAG    0.00210    0.04205    1.05000    [illegible]
                                 0.95000    1.05000    0.02500
 110 UKAIHYD2     3 UKAIHYDG     0.00157    0.03146    1.04100
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                                  0.95000    1.05000    0.02500     0.000
109 UKAITHE2     4 UKAITHEG       0.00067    0.01338    1.03600   1010.00
                                  0.95000    1.05000    0.02500     0.000
 54 UKAITHE4   109 UKAITHE2       0.00183    0.03665    0.95000    315.00
                                  0.95000    1.05000    0.02500     0.000
116 WANAKBO2     5 WANAKBIG       0.00097    0.01938    1.04500    750.00
                                  0.95000    1.05000    0.02500     0.000
 52 WANAKBO4     6 WANAKBEG       0.00072    0.01448    1.05000   1000.00
                                  0.95000    1.05000    0.02500     0.000
 52 WANAKBO4   116 WANAKBO2       0.00212    0.04245    0.95000    315.00
                                  0.95000    1.05000    0.02500     0.000
130 GANDHIN2     7 GANDHING       0.00063    0.01268    1.03600   1030.00
                                  0.95000    1.05000    0.02500     0.000
135 PANANDR2     8 PANANDRG       0.00214    0.04275    1.04500    300.00
                                  0.95000    1.05000    0.02500     0.000
117   KADANA2    9   KADANAG      0.00218    0.04365    1.04100    300.00
                                  0.95000    1.05000    0.02500     0.000
517   AECOMP1   11 AECOMPDG       0.00072    0.01448    1.04500    940.00
                                  0.95000    1.05000    0.02500     0.000
528    GIPCL1   13    GIPCLG      0.00187    0.03745    1.04500    400.00
                                  0.95000    1.05000    0.02500     0.000
 51     ASOJ4  113     ASOJ2      0.00061    0.01218    0.95000   1000.00
                                  0.95000    1.05000    0.02500     0.000
113     ASOJ2  521     ASOJ1      0.00157    0.03146    0.97500    300.00
                                  0.95000    1.05000    0.02500     0.000
 53   JETPUR4  124   JETPUR2      0.00061    0.01218    0.95000    945.00
                                  0.95000    1.05000    0.02500     0.000
 55     SOJA4  131     SOJA2      0.00063    0.01258    0.95000   1000.00
                                  0.95000    1.05000    0.02500     0.000
111 ACHHALI2   527 ACHHALI1       0.00164    0.03276    0.97500    300.00
                                  0.95000    1.05000    0.02500     0.000
112 JAMBUVA2   519 JAMBUVA1       0.00246    0.04914    0.97500    200.00
                                  0.95000    1.05000    0.02500     0.000
119 RANASAN2   504 RANASAN1       0.00088    0.01768    0.97500    550.00
                                  0.95000    1.05000    0.02500     0.000
120 KARAMSA2   502 KARAMSA1       0.00249    0.04984    0.97500    200.00
                                  0.95000    1.05000    0.02500     0.000
121    LIMDI2  510    LIMDI1      0.00211    0.04215    0.97500    200.00
                                  0.95000    1.05000    0.02500     0.000
123   GONDAL2  513   GONDAL1      0.00246    0.04914    0.97500    200.00
                                  0.95000    1.05000    0.02500     0.000
134    ANJAR2  506    ANJAR1      0.00216    0.04325    0.97500    200.00
                                  0.95000    1.05000    0.02500     0.000
138 RANAVAV2   515 RANAVAV1       0.00246    0.04914    0.97500    200.00
                                  0.95000    1.05000    0.02500     0.000
 57 CHORANI4   168 CHORANI2       0.00062    0.01248    0.95000   1000.00
                                  0.95000    1.05000    0.02500     0.000
 58   JHANOR4  155   JHANOR2      0.00063    0.01258    0.95000   1000.00
                                  0.95000    1.05000    0.02500     0.000
 56    KASOR4  169    KASOR2      0.00092    0.01838    0.95000    630.00
                                  0.95000    1.05000    0.02500     0.000
 59   DEHGAM4  166   DEHGAM2      0.00092    0.01838    0.95000    630.00
                                  0.95000    1.05000    0.02500     0.000
146    UTRAN2   14   UTRANEG      0.00312    0.06242    1.04100    200.00
                                  0.95000    1.05000    0.02500     0.000
147    KAWAS2   15    KAWASG      0.00089    0.01778    1.04100    740.00
                                  0.95000    1.05000    0.02500     0.000
14[illegible] KAKPAPA2   16 KAKRAPAG      0.00115    [illegible]    1.04100    [illegible]
                                  0.95000    [illegible]    0.02500
155   JHANOR2   10   JHANORG      0.00078    [illegible]    [illegible]    5[illegible]
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   155                                      0.95000   1.05000   0.02500    0.000
 3  1  154    ESSAR2     17    ESSARG       0.00082   0.01648   1.04500   730.00
   154                                      0.95000   1.05000   0.02500    0.000
 3  1  165 JAMNAGA2     529 JAMNAGA1        0.00491   0.09828   0.97500   100.00
   165                                      0.95000   1.05000   0.02500    0.000
 3  1   60    ZERDA4    143    ZERDA2       0.00099   0.01978   1.04100   630.00
   60                                       0.95000   1.05000   0.02500    0.000
 3  1   18   GTEC-IG    173     GTEC2       0.00084   0.01678   1.04500   843.00
   173                                      0.95000   1.05000   0.02500    0.000
 3  1  173     GTEC2     61     GTEC4       0.00125   0.02497   0.97500   500.00
   61                                       0.95000   1.05000   0.02500    0.000
 3  1   20 MANGROLG     178 MANGROL2        0.00210   0.04205   1.05000   300.00
   178                                      0.95000   1.05000   0.02500    0.000
 3  1   62   AMRELI4    162   AMRELI2       0.00099   0.01978   0.95000   630.00
   62                                       0.95000   1.05000   0.02500    0.000
 3  1   21   GHOGHAG    184   GHOGHA2       0.00140   0.02797   1.04500   450.00
   184                                      0.95000   1.05000   0.02500    0.000
 3  1   23 AKRIMOTG     192 AKRIMOT2        0.00210   0.04205   1.05000   300.00
   192                                      0.95000   1.05000   0.02500    0.000
 3  1   24 MOTIKHAG     193 MOTIKHA2        0.00116   0.02327   1.04100   600.00
   193                                      0.95000   1.05000   0.02500    0.000
 3  1   25 RAMPURAG      65 RAMPURA4        0.00053   0.01059   1.04100  1180.00
   65                                       0.95000   1.05000   0.02500    0.000
 3  1   64 RANCHHO4     187 RANCHHO2        0.00099   0.01978   0.95000   630.00
   64                                       0.95000   1.05000   0.02500    0.000
 3  1   63   RAJKOT4    180 RAJKO-II        0.00099   0.01978   0.95000   630.00
   63                                       0.95000   1.05000   0.02500    0.000
 3  1   26 GTEC-IIG      61     GTEC4       0.00084   0.01678   1.04100   843.00
   61                                       0.95000   1.05000   0.02500    0.000
 3  1   27   DEHGAMG     59   DEHGAM4       0.00086   0.01718   1.04500   825.00
   59                                       0.95000   1.05000   0.02500    0.000

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SMISSION LINE DATA

CKT FROM FROM          TO TO                    LINE PARAMETER          RATING   KMS
    NODE NAME*       NODE NAME*       R(P.U)   X(P.U.)  B/2(P.U.)      MVA
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 1   54 UKAITHE4      51     ASOJ4   0.00260   0.02860   0.38200       824    1.0
 1   52 WANAKBO4      51     ASOJ4   0.00140   0.01540   0.20540       824    1.0
 1   52 WANAKBO4      55     SOJA4   0.00180   0.02000   0.26930       824    1.0
 1   51    ASOJ4      57 CHORANI4    0.00310   0.03400   0.45530       824    1.0
 1   56   KASOR4      57 CHORANI4    0.00190   0.02080   0.27760       824    1.0
 1   51    ASOJ4      56    KASOR4   0.00120   0.01350   0.18040       824    1.0
 2   12  INDORE4      51     ASOJ4   0.00270   0.03010   1.61000      1648    1.0
 1  105 TARAPUR2     106 NAVSARI2    0.02480   0.12470   0.10080       208    1.0
 1  105 TARAPUR2     107     VAPI2   0.01320   0.06650   0.05380       208    1.0
 2  101    NASIK2    106 NAVSARI2    0.01330   0.07050   0.24320       416    1.0
 1  109 UKAITHE2     108 VALTHAN2    0.01020   0.05160   0.04160       208    1.0
 3  109 UKAITHE2     111 ACHHALI2    0.00430   0.02280   0.17700       624    1.0
 2  109 UKAITHE2     110 UKAIHYD2    0.00050   0.00250   0.00840       416    1.0
 2  148 KAKRAPA2     108 VALTHAN2    0.00350   0.01750   0.05640       416    1.0
 2  148 KAKRAPA2     141 HALDARV2    0.00600   0.03030   0.09820       416    1.0
 2  148 KAKRAPA2     107     VAPI2   0.00980   0.04900   0.15860       416    1.0
 2  110 UKAIHYD2     111 ACHHALI2    0.00640   0.03420   0.11820       416    1.0
 2  146    UTRAN2    144      KIM2   0.00200   0.01010   0.03280       416    1.0
 2  147    KAWAS2    106 NAVSARI2    0.00380   0.01910   0.06180       416    1.0
 2  147    KAWAS2    108 VALTHAN2    0.00300   0.01500   0.04840       416    1.0
 2  147    KAWAS2    141 HALDARV2    0.00670   0.03370   0.10880       416    1.0
 2  147    KAWAS2    142 ICHHAPU2    0.00070   0.00330   0.01080       416    1.0
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1	108	VALTHAN2	144	KIM2	0.00350	0.01750	0.01410	208	1.0
1	144	KIM2	156	ZAGADIA2	0.00350	0.01750	0.01410	208	1.0
1	156	ZAGADIA2	141	HALDARV2	0.00680	0.03410	0.02760	208	1.0
1	141	HALDARV2	112	JAMBUVA2	0.01270	0.06400	0.05170	208	1.0
4	111	ACHHALI2	112	JAMBUVA2	0.00180	0.00970	0.13360	832	1.0
1	112	JAMBUVA2	113	ASOJ2	0.00370	0.01980	0.01710	208	1.0
1	112	JAMBUVA2	103	WAGODIA2	0.00410	0.02170	0.01870	208	1.0
1	103	WAGODIA2	113	ASOJ2	0.00500	0.02640	0.02280	208	1.0
2	112	JAMBUVA2	120	KARAMSA2	0.00410	0.02080	0.06720	416	1.0
2	113	ASOJ2	120	KARAMSA2	0.00340	0.01810	0.06260	416	1.0
2	116	WANAKBO2	113	ASOJ2	0.00650	0.03240	0.10480	416	1.0
2	116	WANAKBO2	118	DHANSUR2	0.00500	0.02490	0.08060	416	1.0
2	116	WANAKBO2	145	KAPADWA2	0.00315	0.01580	0.05100	416	1.0
2	145	KAPADWA2	119	RANASAN2	0.00425	0.02140	0.06920	416	1.0
2	117	KADANA2	115	GODHRA2	0.00660	0.03320	0.10760	416	1.0
2	115	GODHRA2	114	CHANDRA2	0.00270	0.01440	0.04980	416	1.0
2	114	CHANDRA2	113	ASOJ2	0.00250	0.01320	0.04560	416	1.0
2	117	KADANA2	118	DHANSUR2	0.00620	0.03120	0.10080	416	1.0
2	118	DHANSUR2	139	HIMATNA2	0.00275	0.01370	0.04440	416	1.0
2	120	KARAMSA2	119	RANASAN2	0.00540	0.02880	0.09960	416	1.0
2	130	GANDHIN2	119	RANASAN2	0.00160	0.00820	0.02860	416	1.0
2	130	GANDHIN2	131	SOJA2	0.00130	0.00660	0.02160	416	1.0
2	130	GANDHIN2	129	CHHATRA2	0.00220	0.01150	0.03980	416	1.0
1	131	SOJA2	136	PALANPU2	0.01570	0.07890	0.06380	208	1.0
1	131	SOJA2	160	KHERALU2	0.01120	0.05650	0.04570	208	1.0
1	160	KHERALU2	136	PALANPU2	0.00840	0.04240	0.03430	208	1.0
2	136	PALANPU2	143	ZERDA2	0.00330	0.01660	0.05380	416	1.0
2	131	SOJA2	137	VIJAPUR2	0.00200	0.01000	0.03240	416	1.0
1	137	VIJAPUR2	139	HIMATNA2	0.00580	0.02910	0.02350	208	1.0
4	131	SOJA2	132	MEHSANA2	0.00160	0.00790	0.10200	832	1.0
1	132	MEHSANA2	134	ANJAR2	0.04320	0.22970	0.19840	208	1.0
1	132	MEHSANA2	158	SANKHAR2	0.01020	0.05440	0.04700	208	1.0
2	135	PANANDR2	134	ANJAR2	0.01320	0.07000	0.24200	416	1.0
2	135	PANANDR2	149	NAKHATR2	0.00580	0.03090	0.10680	416	1.0
2	149	NAKHATR2	150	NANIKHA2	0.00500	0.02490	0.08060	416	1.0
1	128	VIRAMGA2	168	CHORANI2	0.01120	0.05650	0.04570	208	1.0
1	123	GONDAL2	163	RAJKOT2	0.00910	0.04570	0.03700	208	1.0
1	163	RAJKOT2	124	JETPUR2	0.01160	0.05820	0.04700	208	1.0
2	168	CHORANI2	140	DHRANGA2	0.00550	0.02740	0.08880	416	1.0
1	123	GONDAL2	124	JETPUR2	0.00430	0.02160	0.01750	208	1.0
1	124	JETPUR2	138	RANAVAV2	0.01740	0.08730	0.07060	208	1.0
1	124	JETPUR2	152	MOTIPAN2	0.01240	0.06230	0.05040	208	1.0
1	152	MOTIPAN2	138	RANAVAV2	0.01490	0.07480	0.06050	208	1.0
1	124	JETPUR2	127	SAVARKU2	0.01520	0.07650	0.06180	208	1.0
1	124	JETPUR2	151	VISAVAD2	0.00910	0.04570	0.03700	208	1.0
2	124	JETPUR2	165	JAMNAGA2	0.00660	0.03320	0.10760	416	1.0
1	124	JETPUR2	104	SARDGAD2	0.01080	0.05400	0.04370	208	1.0
1	104	SARDGAD2	125	KESHOD2	0.00830	0.04160	0.03360	208	1.0
1	124	JETPUR2	125	KESHOD2	0.01240	0.06230	0.05040	208	1.0
3	120	KARAMSA2	169	KASOR2	0.00080	0.00380	0.02820	624	1.0
1	122	VARTEJ2	127	SAVARKU2	0.01460	0.07750	0.06690	208	1.0
1	127	SAVARKU2	153	DHOKADV2	0.00910	0.04570	0.03700	208	1.0
1	153	DHOKADV2	126	KODINAR2	0.00910	0.04570	0.03700	208	1.0
1	125	KESHOD2	126	KODINAR2	0.01080	0.05400	0.04370	208	1.0
2	166	DEHGAM2	119	RANASAN2	0.00160	0.00810	0.02640	416	1.0
2	166	DEHGAM2	167	KHANPUR2	0.00100	0.00490	0.01580	416	1.0
2	168	CHORANI2	121	LIMDI2	0.00020	0.00120	0.00400	416	1.0
2	155	JHANOR2	141	HALDARV2	0.00110	0.00530	0.01720	416	1.
2	142	ICHHAPU2	154	ESSAR2	0.00120	0.00580	0.01880	416	1.
2	527	ACHHALI1	526	ANKLESH1	0.01350	0.04030	0.01740	168	1.

1	519	JAMBUVA1	524	MIYAGAM1	0.02320	0.06900	0.00750	84	1.0
1	524	MIYAGAM1	525	BHARUCH1	0.02400	0.07130	0.00780	84	1.0
2	525	BHARUCH1	526	ANKLESH1	0.00390	0.01150	0.00500	168	1.0
2	519	JAMBUVA1	523	JAWAHAR1	0.01430	0.04260	0.01860	168	1.0
2	528	GIPCL1	523	JAWAHAR1	0.00085	0.00415	0.01340	168	1.0
2	522	NANDESA1	521	ASOJ1	0.00740	0.02190	0.00960	168	1.0
2	522	NANDESA1	528	GIPCL1	0.00015	0.00085	0.00260	168	1.0
2	523	JAWAHAR1	520	FERTNGR1	0.00270	0.00800	0.00360	168	1.0
2	518	GOTRI1	520	FERTNGR1	0.00310	0.00920	0.00400	168	1.0
2	520	FERTNGR1	521	ASOJ1	0.00460	0.01380	0.00600	168	1.0
2	519	JAMBUVA1	518	GOTRI1	0.00110	0.00540	0.01740	168	1.0
2	518	GOTRI1	501	DHUVARA1	0.01780	0.05290	0.02300	168	1.0
2	501	DHUVARA1	502	KARAMSA1	0.01585	0.04715	0.02060	168	1.0
2	501	DHUVARA1	503	VATWA1	0.02090	0.06210	0.02700	168	1.0
2	503	VATWA1	504	RANASAN1	0.01010	0.02990	0.01300	168	1.0
2	517	AECOMP1	505	SABARMA1	0.00010	0.00020	0.00020	168	1.0
2	505	SABARMA1	504	RANASAN1	0.00500	0.01500	0.00660	168	1.0
2	501	DHUVARA1	510	LIMDI1	0.04450	0.13230	0.05740	168	1.0
2	510	LIMDI1	507	WANKANE1	0.03640	0.10810	0.04700	168	1.0
1	501	DHUVARA1	511	DHANDHU1	0.07740	0.23000	0.02500	84	1.0
1	511	DHANDHU1	512	PALIAD1	0.04720	0.14030	0.01530	84	1.0
1	512	PALIAD1	513	GONDAL1	0.06730	0.20010	0.02180	84	1.0
1	501	DHUVARA1	514	RAJKOT1	0.19350	0.57500	0.06250	84	1.0
1	514	RAJKOT1	513	GONDAL1	0.02860	0.08510	0.00930	84	1.0
1	513	GONDAL1	515	RANAVAV1	0.11220	0.33350	0.03630	84	1.0
1	515	RANAVAV1	516	BHATIA1	0.06580	0.19550	0.02130	84	1.0
2	509	SIKKA1	508	NAGHEDI1	0.01315	0.03910	0.01700	168	1.0
1	508	NAGHEDI1	507	WANKANE1	0.08440	0.25070	0.02730	84	1.0
1	506	ANJAR1	507	WANKANE1	0.12540	0.37260	0.04050	84	1.0
1	507	WANKANE1	529	JAMNAGA1	0.07740	0.23000	0.02500	84	1.0
1	529	JAMNAGA1	509	SIKKA1	0.03480	0.10350	0.01130	84	1.0
1	529	JAMNAGA1	508	NAGHEDI1	0.00700	0.02070	0.00230	84	1.0
1	530	JAMKHAM1	516	BHATIA1	0.02860	0.08510	0.00930	84	1.0
1	509	SIKKA1	530	JAMKHAM1	0.03100	0.09200	0.01000	84	1.0
2	140	DHRANGA2	161	MORBI2	0.00580	0.02910	0.09400	416	1.0
1	55	SOJA4	60	ZERDA4	0.00250	0.02800	0.37480	824	1.0
2	19	SSP4	51	ASOJ4	0.00075	0.00860	0.46080	1648	1.0
4	130	GANDHIN2	159	JAMLA2	0.00087	0.00437	0.05640	832	1.0
4	159	JAMLA2	131	SOJA2	0.00025	0.00125	0.01600	832	1.0
2	167	KHANPUR2	145	KAPADWA2	0.00370	0.01870	0.06040	416	1.0
1	120	KARAMSA2	157	SALEJAD2	0.01210	0.06070	0.04910	208	1.0
1	157	SALEJAD2	168	CHORANI2	0.01210	0.06070	0.04910	208	1.0
1	106	NAVSARI2	170	CHIKHLI2	0.00530	0.02660	0.02150	208	1.0
1	170	CHIKHLI2	107	VAPI2	0.00760	0.03820	0.03090	208	1.0
2	141	HALDARV2	172	WAGRA2	0.00165	0.00830	0.02680	416	1.0
2	143	ZERDA2	171	THARAD2	0.00465	0.02325	0.07520	416	1.0
1	61	GTEC4	58	JHANOR4	0.00020	0.00210	0.02780	824	1.0
2	141	HALDARV2	173	GTEC2	0.00075	0.00375	0.01200	416	1.0
2	173	GTEC2	120	KARAMSA2	0.00860	0.04320	0.13980	416	1.0
1	61	GTEC4	56	KASOR4	0.00190	0.02080	0.27760	824	1.0
1	51	ASOJ4	62	AMRELI4	0.00500	0.05600	0.74950	824	1.0
1	62	AMRELI4	53	JETPUR4	0.00220	0.02490	0.33310	824	1.0
1	52	WANAKBO4	59	DEHGAM4	0.00160	0.01760	0.23600	824	1.0
1	59	DEHGAM4	55	SOJA4	0.00060	0.00660	0.08880	824	1.0
2	154	ESSAR2	164	SACHIN2	0.00265	0.01330	0.04300	416	1.0
2	162	AMRELI2	176	DHASA2	0.00290	0.01455	0.04700	416	1.0
2	162	AMRELI2	127	SAVARKU2	0.00290	0.01455	0.04700	416	1.0
2	178	MANGROL2	156	ZAGADIA2	0.00290	0.01455	0.04700	416	1.0
2	178	MANGROL2	174	MOBHA2	0.00825	0.04155	0.13500	416	1.0
1	108	VALTHAN2	156	ZAGADIA2	0.01080	0.05400	0.04370	208	1.

3	1	156	ZAGADIA2	112	JAMBUVA2	0.01080	0.05400	0.04370	208	1.0
3	2	106	NAVSARI2	164	SACHIN2	0.00215	0.01080	0.03500	416	1.0
3	1	122	VARTEJ2	102	PALITAN2	0.00740	0.03740	0.03020	208	1.0
3	2	133	DEODAR2	143	ZERDA2	0.00370	0.01870	0.06040	416	1.0
3	1	102	PALITAN2	127	SAVARKU2	0.01160	0.05820	0.04700	208	1.0
3	1	121	LIMDI2	177	CHOTILA2	0.01160	0.05820	0.04700	208	1.0
3	1	131	SOJA2	179	SANTHAL2	0.00610	0.03070	0.02490	208	1.0
3	1	131	SOJA2	175	JOTANA2	0.00550	0.02740	0.02220	208	1.0
3	1	175	JOTANA2	179	SANTHAL2	0.00550	0.02740	0.02220	208	1.0
3	1	120	KARAMSA2	184	GHOGHA2	0.02890	0.14540	0.11760	208	1.0
3	2	184	GHOGHA2	122	VARTEJ2	0.00250	0.01245	0.04040	416	1.0
3	2	169	KASOR2	174	MOBHA2	0.00415	0.02080	0.06720	416	1.0
3	2	184	GHOGHA2	102	PALITAN2	0.00495	0.02495	0.08060	416	1.0
3	2	127	SAVARKU2	181	MAHUVA2	0.00345	0.01745	0.05640	416	1.0
3	3	109	UKAITHE2	182	BARDOLI2	0.00353	0.01773	0.12900	624	1.0
3	1	182	BARDOLI2	108	VALTHAN2	0.00480	0.02410	0.01950	208	1.0
3	2	186	BHILAD2	107	VAPI2	0.00265	0.01330	0.04300	416	1.0
3	2	170	CHIKHLI2	108	VALTHAN2	0.00495	0.02495	0.08060	416	1.0
3	2	143	ZERDA2	183	JANGRAL2	0.00330	0.01660	0.05380	416	1.0
3	2	175	JOTANA2	158	SANKHAR2	0.00330	0.01660	0.05380	416	1.0
3	2	65	RAMPURA4	62	AMRELI4	0.00085	0.00935	0.49960	1648	1.0
3	2	59	DEHGAM4	64	RANCHHO4	0.00055	0.00625	0.33320	1648	1.0
3	1	64	RANCHHO4	60	ZERDA4	0.00280	0.03110	0.41640	824	1.0
3	1	129	CHHATRA2	187	RANCHHO2	0.00410	0.02080	0.01680	208	1.0
3	1	187	RANCHHO2	128	VIRAMGA2	0.00600	0.02990	0.02420	208	1.0
3	2	187	RANCHHO2	175	JOTANA2	0.00330	0.01660	0.05380	416	1.0
	2	180	RAJKO-II	161	MORBI2	0.00580	0.02910	0.09400	416	1.0
	2	154	ESSAR2	188	OLPAD2	0.00290	0.01455	0.04700	416	1.0
	1	192	AKRIMOT2	135	PANANDR2	0.00500	0.02490	0.02020	208	1.0
	2	192	AKRIMOT2	149	NAKHATR2	0.00785	0.03945	0.12760	416	1.0
	2	193	MOTIKHA2	165	JAMNAGA2	0.00250	0.01245	0.04040	416	1.0
	2	193	MOTIKHA2	163	RAJKOT2	0.01075	0.05400	0.17480	416	1.0
	2	193	MOTIKHA2	152	MOTIPAN2	0.00560	0.02825	0.09140	416	1.0
	1	158	SANKHAR2	189	RADHANP2	0.01320	0.06650	0.05380	208	1.0
	2	189	RADHANP2	133	DEODAR2	0.00370	0.01870	0.06040	416	1.0
	1	189	RADHANP2	190	CHITROD2	0.01650	0.08310	0.06720	208	1.0
	1	190	CHITROD2	134	ANJAR2	0.02150	0.10800	0.08740	208	1.0
	2	64	RANCHHO4	57	CHORANI4	0.00075	0.00830	0.44420	1648	1.0
	2	150	NANIKHA2	190	CHITROD2	0.01325	0.06650	0.21500	416	1.0
	1	190	CHITROD2	161	MORBI2	0.01650	0.08310	0.06720	208	1.0
	1	116	WANAKBO2	196	SEVALIA2	0.00130	0.00660	0.00540	208	1.0
	1	196	SEVALIA2	115	GODHRA2	0.00580	0.02910	0.02350	208	1.0
	2	139	HIMATNA2	195	MATHASU2	0.00415	0.02080	0.06720	416	1.0
	2	65	RAMPURA4	57	CHORANI4	0.00185	0.02075	1.11040	1648	1.0
	1	57	CHORANI4	63	RAJKOT4	0.00310	0.03420	0.45800	824	1.0
	1	63	RAJKOT4	53	JETPUR4	0.00140	0.01560	0.20820	824	1.0
	2	180	RAJKO-II	163	RAJKOT2	0.00085	0.01245	0.04040	416	1.0
	1	123	GONDAL2	180	RAJKO-II	0.00830	0.04160	0.03360	208	1.0
	1	180	RAJKO-II	177	CHOTILA2	0.00830	0.04160.	0.03360	208	1.0
	1	184	GHOGHA2	169	KASOR2	0.02700	0.13550	0.10950	208	1.0
	2	182	BARDOLI2	170	CHIKHLI2	0.00330	0.01660	0.05380	416	1.0
	2	178	MANGROL2	182	BARDOLI2	0.00415	0.02080	0.06720	416	1.0
	2	509	SIKKA1	516	BHATIA1	0.02710	0.08050	0.03500	168	1.0
	2	188	OLPAD2	144	KIM2	0.00290	0.01455	0.04700	416	1.0
	1	62	AMRELI4	63	RAJKOT4	0.00190	0.02080	0.27760	824	1.0
	1	64	RANCHHO4	55	SOJA4	0.00090	0.01040	0.13880	824	1.0
	2	61	GTEC4	64	RANCHHO4	0.00170	0.01870	0.99940	1648	1.0
	1	170	CHIKHLI2	186	BHILAD2	0.01160	0.05820	0.04700	208	1.0
	1	58	JHANOR4	66	PADGHE4	0.00560	0.06230	0.83230	824	1.0
	2	58	JHANOR4	56	KASOR4	0.00110	0.01245	0.666[illegible]0	1648	1.0

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] 2   56   KASOR4    59  DEHGAM4   0.00135   0.01505   0.80500   1648   1.0
-----------------------------------------------------------------------------
AL LINE CHARGING SUSCEPTANCE             :   44.60300
AL LINE CHARGING MVAR AT 1 PU VOLTAGE :   4460.300
-----------------------------------------------------------------------------
AL CAPACITIVE SUSCEPTANCE               :   0.00000 pu -    0.000 MVAR
AL INDUCTIVE SUSCEPTANCE                :   0.00000 pu -    0.000 MVAR

-----------------------------------------------------------------------------
ERATOR DATA

O* FROM FROM            REAL      Q-MIN      Q-MAX    V-SPEC CAP.     MVA
   NODE NAME*      POWER(MW)       MVAR       MVAR      P.U. CURV  RATING
--- ---- --------- --------- --------- --------- --------- ---- -------
 1    1 DHUVARAG  449.0000    0.0000  189.0000    1.0000    0  100.00
 2    2    SIKKAG  192.0000    0.0000   96.0000    1.0000    0  100.00
 3    3 UKAIHYDG  154.0000    0.0000   65.0000    1.0000    0  100.00
 4    4 UKAITHEG  680.0000    0.0000  286.0000    1.0000    0  100.00
 5    5 WANAKBIG  504.0000    0.0000  212.0000    1.0000    0  100.00
 6    6 WANAKBEG  672.0000    0.0000  282.0000    1.0000    0  100.00
 7    7 GANDHING    0.0000    0.0000  329.0000    1.0000    0  100.00
 8    8 PANANDRG  172.0000    0.0000   86.0000    1.0000    0  100.00
 9    9  KADANAG  200.0000    0.0000   84.0000    1.0000    0  100.00
10   10  JHANORG  580.0000    0.0000  244.0000    1.0000    0  100.00
11   11 AECOMPDG  672.0000    0.0000  282.0000    1.0000    0  100.00
12   12  INDORE4  483.0000 -100.0000  203.0000    1.0000    0  100.00
13   13   GIPCLG  296.0000    0.0000  124.0000    1.0000    0  100.00
14   14  UTRANEG  131.0000    0.0000   66.0000    1.0000    0  100.00
15   15   KAWASG  625.0000    0.0000  263.0000    1.0000    0  100.00
16   16 KAKRAPAG  352.0000    0.0000  148.0000    1.0000    0  100.00
17   17   ESSARG  310.0000    0.0000  130.0000    1.0000    0  100.00
18   18  GTEC-IG  640.0000   32.0000  269.0000    1.0000    0  100.00
19   19     SSP4  232.0000   12.0000   97.0000    1.0000    0  100.00
20   20 MANGROLG  200.0000   10.0000   84.0000    1.0000    0  100.00
21   21  GHOGHAG  300.0000   15.0000  126.0000    1.0000    0  100.00
22   23 AKRIMOTG  200.0000   10.0000   84.0000    1.0000    0  100.00
23   24 MOTIKHAG  400.0000   20.0000  168.0000    1.0000    0  100.00
24   25 RAMPURAG  800.0000   40.0000  336.0000    1.0000    0  100.00
25   26 GTEC-IIG  640.0000   32.0000  269.0000    1.0000    0  100.00
26   27  DEHGAMG  700.0000   35.0000  294.0000    1.0000    0  100.00

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OAD DATA

NO FROM FROM          REAL REACTIVE     COMP COMPENSATING MVAR VALUE CHAR FREQ
   NODE NAME*           MW     MVAR     MVAR      MIN      MAX   STEP   NO   NO
--- ---- -------- -------- -------- -------- -------- -------- ------- ---- ----
 1   12  INDORE4    0.000    0.000 -100.000    0.000    0.000   0.000    0    0
 2   51    ASOJ4    0.000    0.000 -150.000    0.000    0.000   0.000    0    0
 3   62  AMRELI4    0.000    0.000  -50.000    0.000    0.000   0.000    0    0
 4   66  PADGHE4  270.000    0.000    0.000    0.000    0.000   0.000    0    0
 5  101   NASIK2    0.000    0.000    0.000    0.000    0.000   0.000    0    0
 6  102 PALITAN2   75.000   66.000   20.000    0.000    0.000   0.000    0    0
 7  103 WAGODIA2   80.000   70.000   15.000    0.000    0.000   0.000    0    0
 8  104 SARDGAD2   55.000   48.000   30.000    0.000    0.000   0.000    0    0
 9  105 TARAPUR2    0.000    0.000    0.000    0.000    0.000   0.000    0    0
10  106 NAVSARI2  265.000  199.000  110.000    0.000    0.000   0.000    0    0
11  107    VAPI2  300.000  186.000  110.000    0.000    0.000   0.000    0    0
12  108 VALTHAN2  360.000  223.000  150.000    0.000    0.000   0.000    0    0
13  110 UKAIHYD2   80.000   60.000   40.000    0.000    0.000   0.000    0    0
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14	111	ACHHALI2	130.000	98.000	65.000	0.000	0.000	0.000	0	0
15	114	CHANDRA2	100.000	75.000	50.000	0.000	0.000	0.000	0	0
16	115	GODHRA2	130.000	98.000	50.000	0.000	0.000	0.000	0	0
17	118	DHANSUR2	90.000	79.000	50.000	0.000	0.000	0.000	0	0
18	122	VARTEJ2	150.000	113.000	85.000	0.000	0.000	0.000	0	0
19	124	JETPUR2	110.000	97.000	70.000	0.000	0.000	0.000	0	0
20	125	KESHOD2	110.000	97.000	75.000	0.000	0.000	0.000	0	0
21	126	KODINAR2	110.000	83.000	60.000	0.000	0.000	0.000	0	0
22	127	SAVARKU2	125.000	110.000	95.000	0.000	0.000	0.000	0	0
23	128	VIRAMGA2	140.000	105.000	55.000	0.000	0.000	0.000	0	0
24	129	CHHATRA2	210.000	158.000	130.000	0.000	0.000	0.000	0	0
25	132	MEHSANA2	400.000	352.000	230.000	0.000	0.000	0.000	0	0
26	133	DEODAR2	95.000	84.000	75.000	0.000	0.000	0.000	0	0
27	134	ANJAR2	140.000	123.000	70.000	0.000	0.000	0.000	0	0
28	135	PANANDR2	50.000	44.000	5.000	0.000	0.000	0.000	0	0
29	136	PALANPU2	150.000	132.000	75.000	0.000	0.000	0.000	0	0
30	137	VIJAPUR2	135.000	119.000	90.000	0.000	0.000	0.000	0	0
31	139	HIMATNA2	100.000	88.000	60.000	0.000	0.000	0.000	0	0
32	140	DHRANGA2	145.000	128.000	90.000	0.000	0.000	0.000	0	0
33	141	HALDARV2	280.000	210.000	70.000	0.000	0.000	0.000	0	0
34	142	ICHHAPU2	75.000	47.000	25.000	0.000	0.000	0.000	0	0
35	143	ZERDA2	110.000	97.000	85.000	0.000	0.000	0.000	0	0
36	144	KIM2	170.000	105.000	65.000	0.000	0.000	0.000	0	0
37	145	KAPADWA2	60.000	53.000	30.000	0.000	0.000	0.000	0	0
38	146	UTRAN2	160.000	99.000	25.000	0.000	0.000	0.000	0	0
39	149	NAKHATR2	60.000	53.000	30.000	0.000	0.000	0.000	0	0
40	150	NANIKHA2	90.000	79.000	40.000	0.000	0.000	0.000	0	0
41	151	VISAVAD2	50.000	44.000	35.000	0.000	0.000	0.000	0	0
42	152	MOTIPAN2	65.000	57.000	25.000	0.000	0.000	0.000	0	0
43	153	DHOKADV2	42.000	37.000	25.000	0.000	0.000	0.000	0	0
44	156	ZAGADIA2	50.000	31.000	10.000	0.000	0.000	0.000	0	0
45	157	SALEJAD2	100.000	75.000	30.000	0.000	0.000	0.000	0	0
46	158	SANKHAR2	110.000	97.000	50.000	0.000	0.000	0.000	0	0
47	159	JAMLA2	100.000	88.000	55.000	0.000	0.000	0.000	0	0
48	160	KHERALU2	95.000	84.000	45.000	0.000	0.000	0.000	0	0
49	161	MORBI2	125.000	94.000	55.000	0.000	0.000	0.000	0	0
50	162	AMRELI2	110.000	97.000	45.000	0.000	0.000	0.000	0	0
51	163	RAJKOT2	190.000	118.000	85.000	0.000	0.000	0.000	0	0
52	164	SACHIN2	130.000	81.000	40.000	0.000	0.000	0.000	0	0
53	165	JAMNAGA2	130.000	98.000	55.000	0.000	0.000	0.000	0	0
54	167	KHANPUR2	300.000	225.000	45.000	0.000	0.000	0.000	0	0
55	170	CHIKHLI2	70.000	53.000	20.000	0.000	0.000	0.000	0	0
56	171	THARAD2	85.000	75.000	65.000	0.000	0.000	0.000	0	0
57	172	WAGRA2	70.000	53.000	15.000	0.000	0.000	0.000	0	0
58	174	MOBHA2	70.000	53.000	25.000	0.000	0.000	0.000	0	0
59	175	JOTANA2	100.000	88.000	50.000	0.000	0.000	0.000	0	0
60	176	DHASA2	60.000	53.000	20.000	0.000	0.000	0.000	0	0
61	177	CHOTILA2	45.000	40.000	20.000	0.000	0.000	0.000	0	0
62	179	SANTHAL2	30.000	19.000	0.000	0.000	0.000	0.000	0	0
63	180	RAJKO-II	120.000	74.000	50.000	0.000	0.000	0.000	0	0
64	181	MAHUVA2	65.000	49.000	25.000	0.000	0.000	0.000	0	0
65	182	BARDOLI2	105.000	79.000	30.000	0.000	0.000	0.000	0	0
66	183	JANGRAL2	70.000	62.000	50.000	0.000	0.000	0.000	0	0
67	186	BHILAD2	130.000	81.000	50.000	0.000	0.000	0.000	0	0
68	187	RANCHHO2	180.000	112.000	40.000	0.000	0.000	0.000	0	0
69	188	OLPAD2	65.000	40.000	15.000	0.000	0.000	0.000	0	0
70	189	RADHANP2	55.000	48.000	15.000	0.000	0.000	0.000	0	0
71	190	CHITROD2	45.000	40.000	25.000	0.000	0.000	0.000	0	0
72	195	MATHASU2	75.000	66.000	30.000	0.000	0.000	0.000	0	0
73	196	SEVALIA2	45.000	40.000	0.000	0.000	0.000	0.000	0	0

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74  502 KARAMSA1   215.000   161.000    80.000   0.000   0.000   0.000   0
75  503   VATWA1   150.000   113.000    50.000   0.000   0.000   0.000   0
76  504 RANASAN1   180.000   135.000    85.000   0.000   0.000   0.000   0
77  506   ANJAR1   105.000    79.000    40.000   0.000   0.000   0.000   0
78  507 WANKANE1   100.000    88.000    50.000   0.000   0.000   0.000   0
79  508 NAGHEDI1    75.000    56.000    35.000   0.000   0.000   0.000   0
80  509   SIKKA1    50.000    38.000    20.000   0.000   0.000   0.000   0
81  510   LIMDI1   100.000    88.000    46.000   0.000   0.000   0.000   0
82  511 DHANDHU1    40.000    35.000    35.000   0.000   0.000   0.000   0
83  512  PALIAD1    70.000    62.000    60.000   0.000   0.000   0.000   0
84  513  GONDAL1   150.000   132.000   105.000   0.000   0.000   0.000   0
85  514  RAJKOT1    85.000    53.000    50.000   0.000   0.000   0.000   0
86  515 RANAVAV1   110.000    83.000    65.000   0.000   0.000   0.000   0
87  516  BHATIA1    65.000    57.000    35.000   0.000   0.000   0.000   0
88  517  AECOMP1   550.000   341.000   340.000   0.000   0.000   0.000   0
89  518   GOTRI1   140.000    87.000    60.000   0.000   0.000   0.000   0
90  519 JAMBUVA1   120.000    90.000    60.000   0.000   0.000   0.000   0
91  520 FERTNGR1    80.000    50.000     0.000   0.000   0.000   0.000   0
92  521    ASOJ1    75.000    47.000    40.000   0.000   0.000   0.000   0
93  522 NANDESA1    80.000    50.000     0.000   0.000   0.000   0.000   0
94  523 JAWAHAR1    80.000    50.000     0.000   0.000   0.000   0.000   0
95  530 JAMKHAM1    35.000    31.000    15.000   0.000   0.000   0.000   0
-----------------------------------------------------------------------------------------
OTAL SPECIFIED MW GENERATION          : 10584.00000
TOTAL MIN MVAR LIMIT OF GENERATOR     :   106.00000
TOTAL MAX MVAR LIMIT OF GENERATOR     :  4816.00000
TOTAL SPECIFIED MW LOAD               : 10847.00000
TOTAL SPECIFIED MVAR LOAD             :  8055.00000
TOTAL SPECIFIED MVAR COMPENSATION     :  4441.00000
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GENERATOR DATA FOR FREQUENCY DEPENDENT LOAD FLOW

SLNO*  FROM FROM          P-RATE      P-MIN      P-MAX    %DROOP     PARTICI      BIAS
       NODE NAME*             MW         MW         MW                FACTOR    SETTIN
                                                               C0         C1          C
----- ---- ---------  --------- ---------  ---------  ---------  ---------  ---------
    1    1 DHUVARAG     70.000    0.0000   449.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    2    2   SIKKAG     70.000    0.0000   192.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    3    3 UKAIHYDG     70.000    0.0000   154.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    4    4 UKAITHEG     70.000    0.0000   680.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    5    5 WANAKBIG     70.000    0.0000   504.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    6    6 WANAKBEG     70.000    0.0000   672.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    7    7 GANDHING     70.000    0.0000   783.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    8    8 PANANDRG     70.000    0.0000   172.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
    9    9  KADANAG     70.000    0.0000   200.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
   10   10  JHANORG     70.000    0.0000   580.0000     4.0000     0.0000     0.000
                                                        0.0000     0.0000     0.000
   11   11 AECOMPDG     70.000    0.0000   672.0000     4.0000     0.0000     0.000
                                                        0.0000     0.000      .00
   12   12  INDORHA     70.000    0.0000   483.0000     4.0000     00         .00
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                                                                    0.0000      0.0000      0.000
 13    13    GIPCLG     70.000      0.0000   296.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 14    14   UTRANEG     70.000      0.0000   131.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 15    15    KAWASG     70.000      0.0000   625.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 16    16  KAKRAPAG     70.000      0.0000   352.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 17    17    ESSARG     70.000      0.0000   310.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 18    18   GTEC-IG     70.000      0.0000   640.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 19    19      SSP4     70.000      0.0000   232.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 20    20  MANGROLG     70.000      0.0000   200.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 21    21   GHOGHAG     70.000      0.0000   300.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 22    23  AKRIMOTG     70.000      0.0000   200.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 23    24  MOTIKHAG     70.000      0.0000   400.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 24    25  RAMPURAG     70.000      0.0000   800.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 25    26  GTEC-IIG     70.000      0.0000   640.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
 26    27   DEHGAMG     70.000      0.0000   700.0000               4.0000      0.0000      0.000
                                                                    0.0000      0.0000      0.000
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ERATION     MAX P BUS      MAX P     MAX Q BUS      MAX Q
 COUNT         NUMBER   PER UNIT        NUMBER   PER UNIT
-------     ---------   --------     ---------   --------
      1            25      8.178           155      6.392
      2           155      1.096           501      0.159
      3            62      0.048            62      0.016
      4            62      0.012            62      0.003
      5            62      0.002            18      1.924
      6            18      0.700            24      0.127
      7            25      0.130           146      0.087
      8            25      0.095           154      0.122
      9            25      0.045            52      0.128
     10            25      0.012           135      0.057
     11            23      0.007           134      0.001
     12            23      0.001           168      0.000

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S VOLTAGES AND POWERS

DE FROM         V-MAG   ANGLE           MW      MVAR            MW      MVAR      MVAR
.  NAME          P.U.  DEGREE          GEN       GEN          LOAD      LOAD      COMP
-- --------    ------  ------     --------  --------      --------  --------  --------
 1 DHUVARAG    1.0000    3.35      449.000    84.189         0.000     0.000     0.000
 2   SIKKAG    1.0000   -8.87      192.000    93.863         0.000     0.000     0.000
 3 UKAIHYDG    1.0000    7.85      154.000    25.815         0.000     0.000     0.000
 4 UKAITHEG    1.0000   10.39      680.000    30.982         0.000     0.000     0.000
 5 WANAKBIG    1.0000    6.68      504.000    75.154         0.000     0.000     0.000
 6 WANAKBEG    1.0000    8.49      672.000   267.218         0.000     0.000     0.000
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7	GANDHING	1.0000	0.00	495.774	164.579	0.000	0.000	0.000	
8	PANANDRG	1.0000	-4.48	172.000	83.209	0.000	0.000	0.000	
9	KADANAG	1.0000	5.86	200.000	29.379	0.000	0.000	0.000	
10	JHANORG	1.0000	11.25	580.000	31.698	0.000	0.000	0.000	
11	AECOMPDG	1.0000	2.97	672.000	84.529	0.000	0.000	0.000	
12	INDORE4	1.0000	10.93	483.000	-76.072	0.000	0.000	-100.000	
13	GIPCLG	1.0000	6.03	296.000	65.358	0.000	0.000	0.000	
14	UTRANEG	1.0000	6.97	131.000	54.190	0.000	0.000	0.000	
15	KAWASG	1.0000	11.15	625.000	101.691	0.000	0.000	0.000	
16	KAKRAPAG	1.0000	9.09	352.000	73.954	0.000	0.000	0.000	
17	ESSARG	1.0000	7.16	310.000	119.806	0.000	0.000	0.000	
18	GTEC-IG	1.0705	11.23	640.000	32.000	0.000	0.000	0.000	#
19	SSP4	1.0087	3.67	232.000	12.000	0.000	0.000	0.000	
20	MANGROLG	1.0767	7.92	200.000	10.000	0.000	0.000	0.000	#
21	GHOGHAG	1.0472	1.07	300.000	15.000	0.000	0.000	0.000	
23	AKRIMOTG	1.0665	-2.79	200.000	10.000	0.000	0.000	0.000	#
24	MOTIKHAG	1.0328	-3.67	400.000	20.000	0.000	0.000	0.000	
25	RAMPURAG	1.0378	4.73	800.000	40.000	0.000	0.000	0.000	
26	GTEC-IIG	1.0608	9.44	640.000	32.000	0.000	0.000	0.000	#
27	DEHGAMG	1.0452	7.51	700.000	35.000	0.000	0.000	0.000	
51	ASOJ4	1.0022	2.56	0.000	0.000	0.000	0.000	-150.000	
52	WANAKBO4	1.0092	2.80	0.000	0.000	0.000	0.000	0.000	
53	JETPUR4	0.9544	-8.14	0.000	0.000	0.000	0.000	0.000	
54	UKAITHE4	0.9978	3.74	0.000	0.000	0.000	0.000	0.000	
55	SOJA4	0.9899	-0.88	0.000	0.000	0.000	0.000	0.000	
56	KASOR4	1.0046	1.60	0.000	0.000	0.000	0.000	0.000	
57	CHORANI4	0.9935	-1.62	0.000	0.000	0.000	0.000	0.000	
58	JHANOR4	1.0113	3.26	0.000	0.000	0.000	0.000	0.000	
59	DEHGAM4	0.9954	0.59	0.000	0.000	0.000	0.000	0.000	
60	ZERDA4	0.9968	-4.18	0.000	0.000	0.000	0.000	0.000	
61	GTEC4	1.0139	3.49	0.000	0.000	0.000	0.000	-50.000	
62	AMRELI4	0.9746	-3.86	0.000	0.000	0.000	0.000	0.000	
63	RAJKOT4	0.9645	-6.70	0.000	0.000	0.000	0.000	0.000	
64	RANCHHO4	0.9955	-0.78	0.000	0.000	0.000	0.000	0.000	
65	RAMPURA4	0.9921	-0.17	0.000	0.000	0.000	0.000	0.000	
66	PADGHE4	1.0366	-6.26	0.000	0.000	270.000	0.000	0.000	
101	NASIK2	1.0265	1.97	0.000	0.000	0.000	0.000	0.000	
102	PALITAN2	0.9856	-5.91	0.000	0.000	75.000	66.000	20.000	
103	WAGODIA2	1.0166	0.74	0.000	0.000	80.000	70.000	15.000	
104	SARDGAD2	0.9663	-13.91	0.000	0.000	55.000	48.000	30.000	
105	TARAPUR2	1.0011	0.09	0.000	0.000	0.000	0.000	0.000	
106	NAVSARI2	1.0089	2.16	0.000	0.000	265.000	199.000	110.000	
107	VAPI2	0.9872	-0.91	0.000	0.000	300.000	186.000	110.000	
108	VALTHAN2	1.0126	2.82	0.000	0.000	360.000	223.000	150.000	
109	UKAITHE2	1.0313	5.16	0.000	0.000	0.000	0.000	0.000	
110	UKAIHYD2	1.0312	5.07	0.000	0.000	80.000	60.000	40.000	
111	ACHHALI2	1.0235	2.47	0.000	0.000	130.000	98.000	65.000	
112	JAMBUVA2	1.0208	1.46	0.000	0.000	0.000	0.000	0.000	
113	ASOJ2	1.0287	0.88	0.000	0.000	0.000	0.000	0.000	
114	CHANDRA2	1.0222	0.04	0.000	0.000	100.000	75.000	50.000	
115	GODHRA2	1.0201	-0.12	0.000	0.000	130.000	98.000	50.000	
116	WANAKBO2	1.0297	1.03	0.000	0.000	0.000	0.000	0.000	
117	KADANA2	1.0271	0.82	0.000	0.000	0.000	0.000	0.000	
118	DHANSUR2	1.0125	-1.59	0.000	0.000	90.000	79.000	50.000	
119	RANASAN2	1.0127	-2.48	0.000	0.000	0.000	0.000	0.000	
120	KARAMSA2	1.0233	0.23	0.000	0.000	0.000	0.000	0.000	
121	LIMDI2	1.0182	-5.19	0.000	0.000	0.000	0.000	0.000	
122	VARTEJ2	0.9888	-5.52	0.000	0.000	150.000	113.000	85.000	
123	GONDAL2	0.9780	-12.19	0.000	0.000	0.000	0.000	0.000	
124	JETPUR2	0.9867	-11.15	0.000	0.000	110.000	97.000	70.000	

25	KESHOD2	0.9610	-14.73	0.000	0.000	110.000	97.000	75.000
26	KODINAR2	0.9518	-15.37	0.000	0.000	110.000	83.000	60.000
127	SAVARKU2	0.9835	-9.29	0.000	0.000	125.000	110.000	95.000
128	VIRAMGA2	0.9996	-6.44	0.000	0.000	140.000	105.000	55.000
129	CHHATRA2	1.0075	-4.96	0.000	0.000	210.000	158.000	130.000
130	GANDHIN2	1.0131	-3.63	0.000	0.000	0.000	0.000	0.000
131	SOJA2	1.0081	-4.46	0.000	0.000	0.000	0.000	0.000
132	MEHSANA2	0.9913	-6.57	0.000	0.000	400.000	352.000	230.000
133	DEODAR2	0.9570	-10.24	0.000	0.000	95.000	84.000	75.000
134	ANJAR2	0.9565	-14.41	0.000	0.000	140.000	123.000	70.000
135	PANANDR2	1.0068	-8.75	0.000	0.000	50.000	44.000	5.000
136	PALANPU2	0.9568	-9.10	0.000	0.000	150.000	132.000	75.000
137	VIJAPUR2	1.0026	-4.76	0.000	0.000	135.000	119.000	90.000
138	RANAVAV2	0.9680	-13.77	0.000	0.000	0.000	0.000	0.000
139	HIMATNA2	1.0014	-3.48	0.000	0.000	100.000	88.000	60.000
140	DHRANGA2	0.9953	-8.98	0.000	0.000	145.000	128.000	90.000
141	HALDARV2	1.0211	4.71	0.000	0.000	280.000	210.000	70.000
42	ICHHAPU2	1.0222	4.46	0.000	0.000	75.000	47.000	25.000
43	ZERDA2	0.9561	-8.95	0.000	0.000	110.000	97.000	85.000
144	KIM2	1.0085	2.35	0.000	0.000	170.000	105.000	65.000
145	KAPADWA2	1.0157	-1.31	0.000	0.000	60.000	53.000	30.000
146	UTRAN2	1.0050	2.21	0.000	0.000	160.000	99.000	25.000
147	KAWAS2	1.0229	4.71	0.000	0.000	0.000	0.000	0.000
148	KAKRAPA2	1.0224	4.40	0.000	0.000	0.000	0.000	0.000
149	NAKHATR2	0.9996	-9.86	0.000	0.000	60.000	53.000	30.000
150	NANIKHA2	0.9884	-11.43	0.000	0.000	90.000	79.000	40.000
151	VISAVAD2	0.9792	-12.48	0.000	0.000	50.000	44.000	35.000
152	MOTIPAN2	0.9786	-11.14	0.000	0.000	65.000	57.000	25.000
153	DHOKADV2	0.9631	-12.86	0.000	0.000	42.000	37.000	25.000
54	ESSAR2	1.0230	4.23	0.000	0.000	0.000	0.000	0.000
55	JHANOR2	1.0353	5.35	0.000	0.000	0.000	0.000	0.000
56	ZAGADIA2	1.0155	2.88	0.000	0.000	50.000	31.000	10.000
57	SALEJAD2	1.0034	-3.98	0.000	0.000	100.000	75.000	30.000
58	SANKHAR2	0.9842	-7.46	0.000	0.000	110.000	97.000	50.000
59	JAMLA2	1.0088	-4.32	0.000	0.000	100.000	88.000	55.000
60	KHERALU2	0.9651	-8.36	0.000	0.000	95.000	84.000	45.000
61	MORBI2	0.9868	-10.91	0.000	0.000	125.000	94.000	55.000
162	AMRELI2	0.9959	-7.77	0.000	0.000	110.000	97.000	45.000
163	RAJKOT2	0.9875	-11.37	0.000	0.000	190.000	118.000	85.000
164	SACHIN2	1.0116	2.68	0.000	0.000	130.000	81.000	40.000
165	JAMNAGA2	0.9802	-10.61	0.000	0.000	130.000	98.000	55.000
166	DEHGAM2	1.0153	-2.07	0.000	0.000	0.000	0.000	0.000
167	KHANPUR2	1.0063	-2.49	0.000	0.000	300.000	225.000	45.000
168	CHORANI2	1.0197	-5.05	0.000	0.000	0.000	0.000	0.000
169	KASOR2	1.0287	0.39	0.000	0.000	0.000	0.000	0.000
170	CHIKHLI2	1.0046	1.62	0.000	0.000	70.000	53.000	20.000
171	THARAD2	0.9509	-10.19	0.000	0.000	85.000	75.000	65.000
172	WAGRA2	1.0170	4.42	0.000	0.000	70.000	53.000	15.000
173	GTEC2	1.0193	5.34	0.000	0.000	0.000	0.000	0.000
174	MOBHA2	1.0228	0.85	0.000	0.000	70.000	53.000	25.000
175	JOTANA2	0.9974	-6.02	0.000	0.000	100.000	88.000	50.000
176	DHASA2	0.9899	-8.23	0.000	0.000	60.000	53.000	20.000
177	CHOTILA2	0.9976	-8.73	0.000	0.000	45.000	40.000	20.000
178	MANGROL2	1.0205	3.33	0.000	0.000	0.000	0.000	0.000
179	SANTHAL2	0.9994	-5.50	0.000	0.000	30.000	19.000	0.000
180	RAJKO-II	0.9934	-10.30	0.000	0.000	120.000	74.000	50.000
181	MAHUVA2	0.9778	-9.93	0.000	0.000	65.000	49.000	25.000
182	BARDOLI2	1.0149	2.97	0.000	0.000	105.000	79.000	30.000
183	JANGRAL2	0.9523	-9.67	0.000	0.000	70.000	62.000	50.000
184	GHOGHA2	0.9973	-3.73	0.000	0.000	0.000	0.000	0.000

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186  BHILAD2   0.9849  -1.23     0.000     0.000   130.000   81.000    50.000
187 RANCHHO2   1.0108  -4.96     0.000     0.000   180.000  112.000    40.000
188   OLPAD2   1.0136   3.04     0.000     0.000    65.000   40.000    15.000
189 RADHANP2   0.9615 -10.41     0.000     0.000    55.000   48.000    15.000
190 CHITROD2   0.9786 -12.23     0.000     0.000    45.000   40.000    25.000
192 AKRIMOT2   1.0108  -7.48     0.000     0.000     0.000    0.000     0.000
193 MOTIKHA2   0.9872  -9.11     0.000     0.000     0.000    0.000     0.000
195 MATHASU2   0.9920  -4.31     0.000     0.000    75.000   66.000    30.000
196 SEVALIA2   1.0255   0.71     0.000     0.000    45.000   40.000     0.000
501 DHUVARA1   1.0335  -1.23     0.000     0.000     0.000    0.000     0.000
502 KARAMSA1   1.0129  -3.24     0.000     0.000   215.000  161.000    80.000
503   VATWA1   1.0044  -4.27     0.000     0.000   150.000  113.000    50.000
504 RANASAN1   1.0237  -3.58     0.000     0.000   180.000  135.000    85.000
505 SABARMA1   1.0319  -2.66     0.000     0.000     0.000    0.000     0.000
506   ANJAR1   0.9610 -16.83     0.000     0.000   105.000   79.000    40.000
507 WANKANE1   0.9670 -14.12     0.000     0.000   100.000   88.000    50.000
508 NAGHEDI1   0.9945 -14.10     0.000     0.000    75.000   56.000    35.000
509   SIKKA1   1.0077 -13.57     0.000     0.000    50.000   38.000    20.000
510   LIMDI1   1.0139  -7.84     0.000     0.000   100.000   88.000    46.000
511 DHANDHU1   0.9534 -14.46     0.000     0.000    40.000   35.000    35.000
512  PALIAD1   0.9394 -19.56     0.000     0.000    70.000   62.000    60.000
513  GONDAL1   0.9727 -17.85     0.000     0.000   150.000  132.000   105.000
514  RAJKOT1   0.9540 -19.55     0.000     0.000    85.000   53.000    50.000
515 RANAVAV1   0.9805 -16.92     0.000     0.000   110.000   83.000    65.000
516  BHATIA1   0.9784 -16.20     0.000     0.000    65.000   57.000    35.000
517  AECOMP1   1.0321  -2.65     0.000     0.000   550.000  341.000   340.000
518   GOTRI1   1.0169  -1.63     0.000     0.000   140.000   87.000    60.000
519 JAMBUVA1   1.0185  -1.49     0.000     0.000   120.000   90.000    60.000
520 FERTNGR1   1.0169  -1.25     0.000     0.000    80.000   50.000     0.000
521    ASOJ1   1.0258  -0.91     0.000     0.000    75.000   47.000    40.000
522 NANDESA1   1.0198  -0.47     0.000     0.000    80.000   50.000     0.000
523 JAWAHAR1   1.0177  -0.85     0.000     0.000    80.000   50.000     0.000
524 MIYAGAM1   1.0303  -0.28     0.000     0.000     0.000    0.000     0.000
525 BHARUCH1   1.0419   0.96     0.000     0.000     0.000    0.000     0.000
526 ANKLESH1   1.0437   1.16     0.000     0.000     0.000    0.000     0.000
527 ACHHALI1   1.0490   1.88     0.000     0.000     0.000    0.000     0.000
528   GIPCL1   1.0201  -0.42     0.000     0.000     0.000    0.000     0.000
529 JAMNAGA1   0.9986 -13.55     0.000     0.000     0.000    0.000     0.000
530 JAMKHAM1   0.9805 -15.71     0.000     0.000    35.000   31.000    15.000
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NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark)  :     1
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark)  :     4
NUMBER OF GENERATORS EXCEEDING MINIMUM Q LIMIT (< mark)   :     0
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark)   :     0

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LINE FLOWS AND LINE LOSSES

SLNO FROM FROM          TO TO                FORWARD              LOSS              %
     NODE NAME        NODE NAME            MW        MVAR       MW      MVAR   LOADING
---  ---- --------    ---- --------  -------- --------  -------- --------  --------
  1   501 DHUVARA1       1 DHUVARAG -447.154  -47.297    1.8445  36.8916     64.3$
  2   509   SIKKA1       2   SIKKAG -191.034  -74.659    0.9602  19.2041     71.2$
  3   110 UKAIHYD2       3 UKAIHYDG -153.616  -18.144    0.3835   7.6709     45.9^
  4   109 UKAITHE2       4 UKAITHEG -676.898   31.030    3.1006  62.0126     67.4$
  5    54 UKAITHE4     109 UKAITHE2  -70.071   58.895    0.1392   2.7840     29.1^
  6   116 WANAKBO2       5 WANAKBIG -501.483  -24.842    2.5156  50.3117     67.9$
  7    52 WANAKBO4       6 WANAKBEG -668.210 -191.480    3.7869  75.7381     72.3$
  8    52 WANAKBO4     116 WANAKBO2   83.454   78.852    0.2479   4.9578     36.4^
  9   130 GANDHIN2       7 GANDHING -494.043 -129.968    1.7306  34.6123     50.7$
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10  135  PANANDR2    8  PANANDRG  -171.208   -67.605   0.7802   15.6042    63.7$
11  117   KADANA2    9   KADANAG  -199.108   -11.545   0.8917   17.8348    67.4$
12  517   AECOMP1   11  AECOMPDG  -668.681   -18.095   3.3217   66.4332    72.1$
13  528    GIPCL1   13    GIPCLG  -294.278   -30.944   1.7208   34.4147    75.8#
14   51     ASOJ4  113     ASOJ2   271.916   217.490   0.6638   13.2751    34.8^
15  113     ASOJ2  521     ASOJ1   112.209    93.995   0.3028    6.0560    48.8^
16   53   JETPUR4  124   JETPUR2   434.550   137.493   1.2540   25.0807    48.2^
17   55     SOJA4  131     SOJA2   534.195   270.536   2.0777   41.5542    59.9$
18  111  ACHHALI2  527  ACHHALI1    34.713     0.822   0.0179    0.3585    11.6&
19  112  JAMBUVA2  519  JAMBUVA1   114.271    57.745   0.3674    7.3484    64.0$
20  119  RANASAN2  504  RANASAN1   119.630    82.763   0.1734    3.4676    26.4^
21  120  KARAMSA2  502  KARAMSA1   132.629    74.350   0.5230   10.4600    76.0#
22  121    LIMDI2  510    LIMDI1   119.631    72.040   0.3768    7.5360    69.8$
23  123   GONDAL2  513   GONDAL1   199.000    61.791   1.0601   21.2028   104.2@
24  134    ANJAR2  506    ANJAR1    94.200    42.497   0.2400    4.7994    51.7$
25  138  RANAVAV2  515  RANAVAV1   110.006    22.271   0.3140    6.2802    56.1$
26   57  CHORANI4  168  CHORANI2   521.238   207.394   1.7963   35.9270    56.1$
27   58   JHANOR4  155   JHANOR2  -306.939   268.507   0.9234   18.4675    40.8^
28   56    KASOR4  169    KASOR2   132.169   160.371   0.3548    7.0968    33.0^
29   59   DEHGAM4  166   DEHGAM2   277.201   177.471   0.9067   18.1349    52.2$
30  146    UTRAN2   14  UTRANEG   -130.373   -41.645   0.6273   12.5453    70.9$
31  147    KAWAS2   15    KAWASG  -621.435   -30.408   3.5641   71.2827    85.6#
32  148  KAKRAPA2   16  KAKRAPAG  -350.507   -44.106   1.4924   29.8479    69.2$
33  155   JHANOR2   10   JHANORG  -577.016    27.947   2.9823   59.6457    77.4#
34  154    ESSAR2   17    ESSARG  -309.090  -101.603   0.9101   18.2021    45.5^
35  165  JAMNAGA2  529  JAMNAGA1    52.761     5.672   0.1369    2.7379    53.1$
36   60    ZERDA4  143    ZERDA2   385.218     3.943   1.6004   32.0072    61.1$
37   18   GTEC-IG  173     GTEC2   639.991    31.999   3.2827   65.6554    76.0#
38  173     GTEC2   61     GTEC4   144.002   126.799   0.4205    8.4108    38.4^
39   20  MANGROLG  178  MANGROL2   199.998    10.000   0.8017   16.0350    66.7$
40   62   AMRELI4  162   AMRELI2   359.919   149.622   1.4275   28.5489    61.9$
41   21   GHOGHAG  184   GHOGHA2   299.995    14.999   1.2561   25.1229    66.7$
42   23  AKRIMOTG  192  AKRIMOT2   199.920     9.999   0.8165   16.3292    66.7$
43   24  MOTIKHAG  193  MOTIKHA2   399.972    19.999   1.8957   37.9140    66.7$
44   25  RAMPURAG   65  RAMPURA4   799.974    40.001   3.4167   68.3357    67.9$
45   64  RANCHHO4  187  RANCHHO2   399.547   191.091   1.7662   35.3239    70.3$
46   63   RAJKOT4  180  RAJKO-II   325.779   105.788   1.1255   22.5104    54.4$
47   26  GTEC-IIG   61     GTEC4   639.986    31.999   3.3174   66.3475    76.0#
48   27   DEHGAMG   59   DEHGAM4   699.979    35.000   4.2177   84.3538    85.0#
49   54  UKAITHE4   51     ASOJ4    70.071   -58.895   0.1396  -74.8608    11.1&
50   52  WANAKBO4   51     ASOJ4    30.930    22.737   0.0393  -41.1172     8.6&
51   52  WANAKBO4   55     SOJA4   327.863    50.778   2.0077  -31.5126    40.8^
52   51     ASOJ4   57  CHORANI4   214.747   -31.852   1.4294  -74.9848    26.4^
53   56    KASOR4   57  CHORANI4   272.299     8.692   1.4212  -39.8576    33.4^
54   51     ASOJ4   56    KASOR4   123.447   -46.451   0.1917  -34.1693    16.0&
55   12   INDORE4   51     ASOJ4   482.998  -176.072   6.3049 -252.4074    31.2^
56  105  TARAPUR2  106  NAVSARI2   -29.184   -10.024   0.2107  -19.3035    14.8&
57  105  TARAPUR2  107     VAPI2    29.184    10.025   0.1435   -9.9124    16.9&
58  101    NASIK2  106  NAVSARI2    -0.000    -0.000   0.0829  -49.9426    12.0&
59  109  UKAITHE2  108  VALTHAN2    86.851    17.487   0.7695   -4.7971    42.7^
60  109  UKAITHE2  111  ACHHALI2   217.270   -19.278   1.9086  -27.2453    35.0^
61  109  UKAITHE2  110  UKAIHYD2    66.406   -11.973   0.0213   -1.6801    16.2&
62  148  KAKRAPA2  108  VALTHAN2   168.253    20.315   0.9708   -6.8247    40.7^
63  148  KAKRAPA2  141  HALDARV2   -17.051    -2.173   0.0204  -20.4003     6.0&
64  148  KAKRAPA2  107     VAPI2   199.307    25.965   3.8935  -12.5683    48.3^
65  110  UKAIHYD2  111  ACHHALI2   140.004   -12.142   1.1796  -18.6474    33.8^
66  146    UTRAN2  144      KIM2   -29.626   -32.354   0.0341   -6.4768    10.5&
67  147    KAWAS2  106  NAVSARI2   246.827    24.430   2.2475   -1.4598    59.6$
68  147    KAWAS2  108  VALTHAN2   233.218    22.106   1.5808   -2.1223    56.3$
69  147    KAWAS2  141  HALDARV2     1.112    -6.157   0.0018  -22.7168     4.0&
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70	147	KAWAS2	142	ICHHAPU2	140.281	-9.968	0.1322	-1.6352	33.8^
71	108	VALTHAN2	144	KIM2	51.113	12.101	0.0954	-2.4026	25.5^
72	144	KIM2	156	ZAGADIA2	-59.733	-29.556	0.1500	-2.1381	32.0^
73	156	ZAGADIA2	141	HALDARV2	-96.500	1.411	0.6153	-2.6384	46.7^
74	141	HALDARV2	112	JAMBUVA2	89.594	-20.119	1.0043	-5.7164	44.1^
75	111	ACHHALI2	112	JAMBUVA2	189.473	-19.349	0.6174	-24.5884	22.9&
76	112	JAMBUVA2	113	ASOJ2	43.761	-50.210	0.1513	-2.7817	32.0^
77	112	JAMBUVA2	103	WAGODIA2	61.693	6.594	0.1526	-3.0733	29.9^
78	103	WAGODIA2	113	ASOJ2	-18.459	-45.332	0.1058	-4.2099	23.5&
79	112	JAMBUVA2	120	KARAMSA2	101.489	-38.089	0.4433	-11.7901	26.1^
80	113	ASOJ2	120	KARAMSA2	70.045	11.093	0.1677	-12.2859	17.7&
81	116	WANAKBO2	113	ASOJ2	8.684	-9.593	0.0048	-22.1766	3.7&
82	116	WANAKBO2	118	DHANSUR2	198.878	26.945	1.9247	-7.2233	48.2^
83	116	WANAKBO2	145	KAPADWA2	278.156	35.542	2.3485	1.1111	67.4$
84	145	KAPADWA2	119	RANASAN2	97.482	-11.034	0.3921	-12.2617	23.6&
85	117	KADANA2	115	GODHRA2	54.199	0.017	0.1919	-21.5813	14.0&
86	115	GODHRA2	114	CHANDRA2	-22.330	-16.070	0.0160	-10.2998	6.6&
87	114	CHANDRA2	113	ASOJ2	-122.345	-30.772	0.3743	-7.6133	30.3^
88	117	KADANA2	118	DHANSUR2	144.909	11.528	1.2630	-14.6108	35.1^
89	118	DHANSUR2	139	HIMATNA2	250.597	31.306	1.7191	-0.4397	60.7$
90	120	KARAMSA2	119	RANASAN2	171.579	-0.906	1.5229	-12.5215	41.2^
91	130	GANDHIN2	119	RANASAN2	-239.991	52.125	0.9450	-1.0254	59.3$
92	130	GANDHIN2	131	SOJA2	231.578	31.151	0.6933	-0.8925	56.2$
93	130	GANDHIN2	129	CHHATRA2	208.273	7.904	0.9328	-3.2495	50.1$
94	131	SOJA2	136	PALANPU2	108.473	41.542	2.1740	-1.3984	55.8$
95	131	SOJA2	160	KHERALU2	128.005	50.726	2.1436	1.9131	66.2$
96	160	KHERALU2	136	PALANPU2	30.864	9.814	0.1012	-5.8237	16.6&
97	136	PALANPU2	143	ZERDA2	-12.931	1.579	0.0076	-9.8046	4.1&
98	131	SOJA2	137	VIJAPUR2	61.834	40.231	0.1125	-5.9868	18.5&
99	137	VIJAPUR2	139	HIMATNA2	-73.275	17.218	0.3319	-3.0532	36.7^
100	131	SOJA2	132	MEHSANA2	491.180	113.142	4.0384	-0.4495	60.6$
101	132	MEHSANA2	134	ANJAR2	57.839	-11.471	1.4990	-29.6759	28.5^
102	132	MEHSANA2	158	SANKHAR2	29.306	3.066	0.0953	-8.6630	15.1&
103	135	PANANDR2	134	ANJAR2	145.589	27.133	3.1079	-30.1864	36.9^
104	135	PANANDR2	149	NAKHATR2	65.694	0.867	0.2548	-20.1396	16.5&
105	149	NAKHATR2	150	NANIKHA2	113.111	15.610	0.6683	-12.6001	27.9^
106	128	VIRAMGA2	168	CHORANI2	-48.974	-29.795	0.3401	-7.6026	27.6^
107	123	GONDAL2	163	RAJKOT2	-32.976	-16.882	0.1204	-6.5425	17.8&
108	163	RAJKOT2	124	JETPUR2	-5.861	-2.061	0.0048	-9.1339	4.4&
109	168	CHORANI2	140	DHRANGA2	263.776	37.519	3.7960	0.8821	64.0$
110	123	GONDAL2	124	JETPUR2	-85.314	-22.957	0.3475	-1.6318	42.5^
111	124	JETPUR2	138	RANAVAV2	52.271	4.954	0.5134	-10.9124	26.0^
112	124	JETPUR2	152	MOTIPAN2	2.070	7.523	0.0202	-9.6309	8.3&
113	152	MOTIPAN2	138	RANAVAV2	58.792	-2.348	0.5397	-8.7527	28.3^
114	124	JETPUR2	127	SAVARKU2	-38.704	6.398	0.2580	-10.6959	20.5&
115	124	JETPUR2	151	VISAVAD2	50.237	3.056	0.2401	-5.9441	24.4&
116	124	JETPUR2	165	JAMNAGA2	-22.858	13.307	0.0738	-20.4426	9.8&
117	124	JETPUR2	104	SARDGAD2	89.115	17.109	0.9317	-3.6765	43.6^
118	104	SARDGAD2	125	KESHOD2	33.187	2.786	0.1010	-5.7345	16.4&
119	124	JETPUR2	125	KESHOD2	99.646	18.818	1.3364	-2.8467	48.8^
120	120	KARAMSA2	169	KASOR2	-107.059	-126.705	0.2046	-4.9655	26.6^
121	122	VARTEJ2	127	SAVARKU2	81.393	-12.459	0.9946	-7.7325	39.6^
122	127	SAVARKU2	153	DHOKADV2	133.167	17.951	1.7119	1.5864	64.6$
123	153	DHOKADV2	126	KODINAR2	89.457	4.365	0.7912	-2.8106	43.1^
124	125	KESHOD2	126	KODINAR2	21.402	8.185	0.0710	-7.6399	12.8&
125	166	DEHGAM2	119	RANASAN2	93.551	12.047	0.1392	-4.7240	22.8&
126	166	DEHGAM2	167	KHANPUR2	182.740	147.285	0.5391	-0.5875	56.4$
127	168	CHORANI2	121	LIMDI2	231.072	84.244	0.1165	-0.1317	59.1$
128	155	JHANOR2	141	HALDARV2	269.149	222.090	1.2580	2.4246	83.9#
129	142	ICHHAPU2	154	ESSAR2	65.152	-30.333	0.0580	-3.6517	17.3&

30	527 ACHHALI1	526	ANKLESH1	34.695	0.464	0.1484	-3.3669	20.7&
31	519 JAMBUVA1	524	MIYAGAM1	-33.969	-6.446	0.2652	-0.7854	41.3^
32	524 MIYAGAM1	525	BHARUCH1	-34.234	-5.660	0.2702	-0.8719	41.5^
133	525 BHARUCH1	526	ANKLESH1	-34.504	-4.788	0.0434	-0.9594	20.7&
134	519 JAMBUVA1	523	JAWAHAR1	-23.826	8.147	0.0923	-3.5813	15.9&
135	528 GIPCL1	523	JAWAHAR1	189.917	18.435	0.2978	-1.3281	113.6@
136	522 NANDESA1	521	ASOJ1	24.337	-37.044	0.1346	-1.6104	26.4^
137	522 NANDESA1	528	GIPCL1	-104.339	-12.977	0.0159	-0.4507	62.6$
138	523 JAWAHAR1	520	FERTNGR1	85.702	-18.514	0.2001	-0.1524	52.2$
139	518 GOTRI1	520	FERTNGR1	-66.205	21.980	0.1464	-0.3927	41.7^
140	520 FERTNGR1	521	ASOJ1	-60.850	-45.988	0.2563	-0.4830	45.4^
141	519 JAMBUVA1	518	GOTRI1	51.699	18.696	0.0328	-3.4433	33.5^
142	518 GOTRI1	501	DHUVARA1	-22.129	-26.840	0.1873	-4.2784	20.7&
143	501 DHUVARA1	502	KARAMSA1	83.989	16.057	1.0962	-1.0530	50.9$
144	501 DHUVARA1	503	VATWA1	95.001	15.976	1.8355	-0.1538	57.3$
145	503 VATWA1	504	RANASAN1	-56.834	-46.870	0.5312	-1.1012	43.8^
146	517 AECOMP1	505	SABARMA1	118.671	17.147	0.0135	-0.0156	71.4$
147	505 SABARMA1	504	RANASAN1	118.598	17.103	0.6753	0.6314	71.3$
148	501 DHUVARA1	510	LIMDI1	88.095	-15.220	3.2676	-2.3176	53.2$
149	510 LIMDI1	507	WANKANE1	104.083	9.605	3.9094	2.3831	62.2$
150	501 DHUVARA1	511	DHANDHU1	102.387	10.244	7.7172	17.9896	122.5@
151	511 DHANDHU1	512	PALIAD1	54.673	-7.745	1.5731	1.9352	65.7$
152	512 PALIAD1	513	GONDAL1	-16.902	-11.681	0.2905	-3.1229	24.5&
153	501 DHUVARA1	514	RAJKOT1	55.370	-2.319	5.5884	4.2426	66.0$
154	514 RAJKOT1	513	GONDAL1	-35.216	-9.562	0.4136	-0.4956	43.8^
155	513 GONDAL1	515	RANAVAV1	-4.874	-4.036	0.0286	-6.8398	7.5&
156	515 RANAVAV1	516	BHATIA1	-5.195	0.795	0.0240	-4.0157	8.4&
157	509 SIKKA1	508	NAGHEDI1	31.581	21.769	0.2006	-2.8112	23.7&
158	508 NAGHEDI1	507	WANKANE1	3.386	7.081	0.0914	-4.9814	14.9&
159	506 ANJAR1	507	WANKANE1	-11.006	-1.296	0.1726	-7.0147	14.9&
160	507 WANKANE1	529	JAMNAGA1	-7.705	-12.995	0.1432	-4.4051	18.0&
161	529 JAMNAGA1	509	SIKKA1	-2.383	-9.163	0.0245	-2.2013	11.3&
162	529 JAMNAGA1	508	NAGHEDI1	47.160	3.508	0.1571	0.0078	56.3$
163	530 JAMKHAM1	516	BHATIA1	9.452	-1.705	0.0268	-1.7047	11.4&
164	509 SIKKA1	530	JAMKHAM1	45.147	14.379	0.6946	0.0845	56.4$
165	140 DHRANGA2	161	MORBI2	114.986	-1.362	0.7779	-14.5612	27.6^
166	55 SOJA4	60	ZERDA4	199.556	-73.047	1.0496	-62.2166	25.8^
167	19 SSP4	51	ASOJ4	231.997	11.999	0.4223	-88.3235	15.3&
168	130 GANDHIN2	159	JAMLA2	294.192	38.789	0.7504	-7.7593	35.7^
169	159 JAMLA2	131	SOJA2	193.440	13.544	0.0925	-2.7918	23.3&
170	167 KHANPUR2	145	KAPADWA2	-117.793	-32.127	0.5316	-9.6614	29.3^
171	120 KARAMSA2	157	SALEJAD2	126.786	7.729	1.8767	-0.6702	61.1$
172	157 SALEJAD2	168	CHORANI2	24.911	-36.600	0.1950	-9.0700	21.3&
173	106 NAVSARI2	170	CHIKHLI2	38.001	6.701	0.0793	-3.9604	18.9&
174	170 CHIKHLI2	107	VAPI2	119.422	21.486	1.1195	-0.5029	58.3$
175	141 HALDARV2	172	WAGRA2	70.097	32.927	0.0980	-5.0734	19.1&
176	143 ZERDA2	171	THARAD2	85.365	-1.814	0.3720	-11.8139	20.6&
177	61 GTEC4	58	JHANOR4	206.829	104.582	0.1057	-4.5918	28.4^
178	141 HALDARV2	173	GTEC2	-284.879	105.701	0.6661	0.8328	73.1$
179	173 GTEC2	120	KARAMSA2	207.158	-55.589	3.6919	-10.6176	51.6$
180	61 GTEC4	56	KASOR4	164.479	4.476	0.5201	-50.8640	21.0&
181	51 ASOJ4	62	AMRELI4	198.969	-32.703	2.0612	-123.3743	26.3^
182	62 AMRELI4	53	JETPUR4	284.312	32.656	1.9681	-39.7012	35.4^
183	52 WANAKBO4	59	DEHGAM4	225.959	39.116	0.8647	-37.9092	28.9^
184	59 DEHGAM4	55	SOJA4	388.017	43.008	0.9280	-7.2925	47.4^
185	154 ESSAR2	164	SACHIN2	219.336	42.765	1.2747	-2.5033	53.7$
186	162 AMRELI2	176	DHASA2	60.128	24.388	0.1304	-8.6125	16.5&
187	162 AMRELI2	127	SAVARKU2	188.367	44.686	1.1088	-3.6447	46.5^
188	178 MANGROL2	156	ZAGADIA2	60.302	18.433	0.1164	-9.1575	15.9&
189	178 MANGROL2	174	MOBHA2	103.822	-38.043	0.8994	-23.6532	26.6^

108	VALTHAN2	156	ZAGADIA2	-2.795	-9.402	0.0034	-8.9703	4.7&
156	ZAGADIA2	112	JAMBUVA2	44.006	-22.670	0.2374	-7.8734	23.8&
106	NAVSARI2	164	SACHIN2	-87.898	-10.590	0.1642	-6.3192	21.3&
122	VARTEJ2	102	PALITAN2	18.568	1.911	0.0279	-5.7450	9.6&
133	DEODAR2	143	ZERDA2	-104.677	21.306	0.4717	-8.6691	26.3^
102	PALITAN2	127	SAVARKU2	95.745	-17.285	1.1141	-3.5218	46.8^
121	LIMDI2	177	CHOTILA2	111.325	12.326	1.4197	-2.4281	53.8$
131	SOJA2	179	SANTHAL2	63.077	14.005	0.2552	-3.7331	31.4^
131	SOJA2	175	JOTANA2	103.768	17.692	0.6043	-1.4542	50.6$
175	JOTANA2	179	SANTHAL2	-32.764	-2.868	0.0594	-4.1301	15.8&
120	KARAMSA2	184	GHOGHA2	50.457	-2.358	0.7300	-20.3372	25.4^
184	GHOGHA2	122	VARTEJ2	251.560	17.464	1.6023	0.0119	60.6$
169	KASOR2	174	MOBHA2	-32.830	28.711	0.0926	-13.6780	12.9&
184	GHOGHA2	102	PALITAN2	153.392	11.210	1.1895	-9.8496	37.0^
127	SAVARKU2	181	MAHUVA2	65.163	13.985	0.1649	-10.0142	16.7&
109	UKAITHE2	182	BARDOLI2	236.163	38.849	1.9428	-17.2491	38.6^
182	BARDOLI2	108	VALTHAN2	12.324	5.371	0.0096	-3.9597	7.4&
186	BHILAD2	107	VAPI2	-42.705	-12.560	0.0517	-8.1019	10.7&
170	CHIKHLI2	108	VALTHAN2	-88.604	-21.696	0.3941	-14.4124	21.9&
143	ZERDA2	183	JANGRAL2	70.176	3.109	0.1801	-8.8912	17.1&
175	JOTANA2	158	SANKHAR2	158.910	44.248	0.9193	-5.9388	39.8^
65	RAMPURA4	62	AMRELI4	678.309	96.507	4.1568	-50.8983	41.9^
59	DEHGAM4	64	RANCHHO4	376.962	-63.751	0.7941	-57.0117	23.2&
64	RANCHHO4	60	ZERDA4	187.725	-56.734	1.0024	-71.5094	23.8&
129	CHHATRA2	187	RANCHHO2	-2.654	-16.846	0.0095	-3.3733	8.2&
187	RANCHHO2	128	VIRAMGA2	91.537	17.887	0.5164	-2.3171	44.8^
187	RANCHHO2	175	JOTANA2	123.583	52.408	0.6016	-7.8220	32.9^
180	RAJKO-II	161	MORBI2	38.627	5.820	0.1011	-17.9225	10.9&
154	ESSAR2	188	OLPAD2	154.847	32.157	0.7025	-6.2233	38.2^
192	AKRIMOT2	135	PANANDR2	90.493	-2.727	0.4007	-2.1160	43.5^
192	AKRIMOT2	149	NAKHATR2	108.586	-3.600	0.9127	-21.2016	26.2^
193	MOTIKHA2	165	JAMNAGA2	206.796	12.601	1.1040	-2.3213	49.8^
193	MOTIKHA2	163	RAJKOT2	68.675	-29.729	0.5380	-31.3776	18.0&
193	MOTIKHA2	152	MOTIPAN2	122.606	-0.787	0.8675	-13.2836	29.5^
158	SANKHAR2	189	RADHANP2	77.205	14.917	0.8675	-5.8147	38.0^
189	RADHANP2	133	DEODAR2	-9.654	19.335	0.0286	-10.9717	7.6&
189	RADHANP2	190	CHITROD2	30.990	-31.602	0.2864	-11.2058	21.3&
190	CHITROD2	134	ANJAR2	35.690	5.248	0.3276	-14.7202	19.5&
64	RANCHHO4	57	CHORANI4	174.121	-33.706	0.2302	-85.3146	11.0&
150	NANIKHA2	190	CHITROD2	22.461	-10 787	0.0826	-41.1812	9.1&
190	CHITROD2	161	MORBI2	-27.607	-10.249	0.1338	-12.3054	14.2&
115	WANAFBC2	196	SEVALIA2	98.970	45.840	0.1465	-0.3955	52.5$
196	SEVALIA2	115	GODHRA2	53.825	6.239	0.1640	-4.0937	26.3^
139	HIMATNA2	195	MATHASU2	75.273	24.021	0.2736	-11.9796	20.0&
65	RAMPURA4	57	CHORANI4	118.247	-124.845	0.2674	-215.8809	10.4&
57	CHORANI4	63	RAJKOT4	254.814	26.933	2.2029	-63.5015	32.6^
63	RAJKOT4	53	JETPUR4	152.601	31.138	0.3889	-33.9968	20.1&
180	RAJKO-II	163	RAJKOT2	149.290	34.703	0.2049	-4.9255	37.1^
123	GONDAL2	180	RAJKO-II	-80.707	-21.954	0.5956	-3.54[illegible]5	40.2^
180	RAJKO-II	177	CHOTILA2	-64.556	0.348	0.3516	-4.8976	31.3^
184	GHOGHA2	169	KASOR2	-56.483	-20.819	0.8929	-17.9975	28.9^
182	BARDOLI2	170	CHIKHLI2	151.902	28.890	0.7772	-7.0618	37.3^
178	MANGROL2	182	BARDOLI2	35.072	13.573	0.0659	-13.5902	10.7&
509	SIKKA1	516	BHATIA1	61.890	13.552	1.1003	-3.6366	37.7^
188	OLPAD2	144	KIM2	89.144	13.378	0.2337	-8.4366	22.0&
62	AMRELI4	63	RAJKOT4	226.827	5.798	1.0499	-40.6935	28.0^
64	RANCHHO4	55	SOJA4	20.841	37.871	0.0281	-27.0316	8.3&
61	GTEC4	64	RANCHHO4	408.940	-25.011	2.8652	-170.2762	26.2^
170	CHIKHLI2	186	BHILAD2	88.228	13.925	0.9343	-4.61[illegible]	42.9^
58	JHANOR4	66	PADGHE4	274.211	-127.761	4.2163	-1[illegible]	36.[illegible]

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250   58  JHANOR4    56   KASOR4   239.445   -31.580   0.6310 -128.2348    15.6&
251   56   KASOR4    59  DEHGAM4   121.559   -29.350   0.2337 -158.4022    10.7&
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NUMBER OF LINES LOADED BEYOND  125%            :   0
NUMBER OF LINES LOADED BETWEEN 100% AND 125% :   3
NUMBER OF LINES LOADED BETWEEN  75% AND 100% :   8
NUMBER OF LINES LOADED BETWEEN  50% AND  75% :  63
NUMBER OF LINES LOADED BETWEEN  25% AND  50% :  92
NUMBER OF LINES LOADED BETWEEN   1% AND  25% :  85
NUMBER OF LINES LOADED BETWEEN   0% AND   1% :   0

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BUS WISE LINE FLOWS AND LINE LOSSES

FROM FROM       TO TO              FORWARD             LOSS
NODE NAME     NODE NAME          MW      MVAR        MW      MVAR
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   1 DHUVARAG  501 DHUVARA1  448.999   84.189   1.8445  36.8916

   2   SIKKAG  509   SIKKA1  191.995   93.863   0.9602  19.2041

   3 UKAIHYDG  110 UKAIHYD2  154.000   25.815   0.3835   7.6709

   4 UKAITHEG  109 UKAITHE2  679.999   30.983   3.1006  62.0126

   5 WANAKBIG  116 WANAKBO2  503.998   75.154   2.5156  50.3117

   6 WANAKBEG   52 WANAKBO4  671.996  267.218   3.7869  75.7381

   7 GANDHING  130 GANDHIN2  495.774  164.580   1.7306  34.6123

   8 PANANDRG  135 PANANDR2  171.989   83.209   0.7802  15.6042

   9  KADANAG  117  KADANA2  199.999   29.380   0.8917  17.8348

  10  JHANORG  155  JHANOR2  579.998   31.698   2.9823  59.6457

  11 AECOMPDG  517  AECOMP1  672.002   84.529   3.3217  66.4332

  12  INDORE4   51    ASOJ4  482.998 -176.072   6.3049 -252.4074

  13   GIPCLG  528   GIPCL1  295.999   65.358   1.7208  34.4147

  14  UTRANEG  146   UTRAN2  131.000   54.190   0.6273  12.5453

  15   KAWASG  147   KAWAS2  624.999  101.691   3.5641  71.2827

  16 KAKRAPAG  148 KAKRAPA2  352.000   73.954   1.4924  29.8479

  17   ESSARG  154   ESSAR2  310.000  119.805   0.9101  18.2021

  18  GTEC-IG  173    GTEC2  639.991   31.999   3.2827  65.6554

  19     SSP4   51    ASOJ4  231.997   11.999   0.4223 -88.3235

  20 MANGROLG  178 MANGROL2  199.998   10.000   0.8017  16.0350

  21  GHOGHAG  184  GHOGHA2  299.995   14.999   1.2561  25.1229
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23 AKRIMOTG   192 AKRIMOT2  199.920     9.999    0.8165   16.3292

24 MOTIKHAG   193 MOTIKHA2  399.972    19.999    1.8957   37.9140

25 RAMPURAG    65 RAMPURA4  799.974    40.001    3.4167   68.3357

26 GTEC-IIG    61    GTEC4  639.986    31.999    3.3174   66.3475

27  DEHGAMG    59  DEHGAM4  699.979    35.000    4.2177   84.3538

51     ASOJ4  113    ASOJ2  271.916   217.490    0.6638   13.2751
51     ASOJ4   54 UKAITHE4  -69.931   -15.966    0.1396  -74.8608
51     ASOJ4   52 WANAKBO4  -30.891   -63.854    0.0393  -41.1172
51     ASOJ4   57 CHORANI4  214.747   -31.852    1.4294  -74.9848
51     ASOJ4   56   KASOR4  123.447   -46.451    0.1917  -34.1693
51     ASOJ4   12  INDORE4 -476.693   -76.336    6.3049 -252.4074
51     ASOJ4   19     SSP4 -231.574  -100.323    0.4223  -88.3235
51     ASOJ4   62  AMRELI4  198.969   -32.703    2.0612 -123.3743

52 WANAKBO4     6 WANAKBEG -668.210  -191.480    3.7869   75.7381
52 WANAKBO4   116 WANAKBO2   83.454    78.852    0.2479    4.9578
52 WANAKBO4    51    ASOJ4   30.930    22.737    0.0393  -41.1172
52 WANAKBO4    55    SOJA4  327.863    50.778    2.0077  -31.5126
52 WANAKBO4    59  DEHGAM4  225.959    39.116    0.8647  -37.9092

53  JETPUR4   124  JETPUR2  434.550   137.493    1.2540   25.0807
53  JETPUR4    62  AMRELI4 -282.344   -72.357    1.9681  -39.7012
53  JETPUR4    63  RAJKOT4 -152.212   -65.135    0.3889  -33.9968

54 UKAITHE4   109 UKAITHE2  -70.071    58.895    0.1392    2.7840
54 UKAITHE4    51    ASOJ4   70.071   -58.895    0.1396  -74.8608

55     SOJA4  131    SOJA2  534.195   270.536    2.0777   41.5542
55     SOJA4   52 WANAKBO4 -325.855   -82.291    2.0077  -31.5126
55     SOJA4   60   ZERDA4  199.556   -73.047    1.0496  -62.2166
55     SOJA4   59  DEHGAM4 -387.089   -50.301    0.9280   -7.2925
55     SOJA4   64 RANCHHO4  -20.813   -64.903    0.0281  -27.0326

56    KASOR4  169   KASOR2  132.169   160.371    0.3548    7.0968
56    KASOR4   57 CHORANI4  272.299     8.692    1.4212  -39.8576
56    KASOR4   51    ASOJ4 -123.255    12.282    0.1917  -34.1693
56    KASOR4   61    GTEC4 -163.959   -55.340    0.5201  -50.3640
56    KASOR4   53  JHANOR4 -238.814   -96.555    0.6310 -128.2348
56    KASOR4   59  DEHGAM4  121.559   -29.350    0.2337 -158.4022

57  CHORANI4  168 CHORANI2  521.238   207.394    1.7963   35.9270
57  CHORANI4   51    ASOJ4 -213.318   -43.133    1.4294  -74.9848
57  CHORANI4   56   KASOR4 -270.877   -48.549    1.4212  -39.8576
57  CHORANI4   64 RANCHHO4 -173.891   -51.609    0.2302  -85.3146
57  CHORANI4   65 RAMPURA4 -117.980   -91.036    0.2674 -215.8803
57  CHORANI4   63  RAJKOT4  254.814    26.933    2.2029  -63.5015

58   JHANOR4  155  JHANOR2 -306.939   268.507    0.9234   18.4675
58   JHANOR4   61    GTEC4 -206.723  -109.174    0.1057   -4.5918
58   JHANOR4   66  PADGHE4  274.211  -127.761    4.2163 -127.7617
59   JHANOR4   56   KASOR4  239.445   -31.580    0.6310 -128.2348

59   DEHGAM4  160  DEHGAM2  277.201   177.471    0.9067   18.1349
59   DEHGAM4   27  DEHGAMG -695.761    49.354    4.2177   84.3538
59   DEHGAM4   52 WANAKBO4 -225.095   -77 025    0.8647  -37.9092
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59  DEHGAM4    55     SOJA4   388.017    43.008    0.9280   -7.2925
59  DEHGAM4    64  RANCHHO4   376.962   -63.751    0.7941  -57.0117
59  DEHGAM4    56    KASOR4  -121.325  -129.052    0.2337 -158.4022

60   ZERDA4   143    ZERDA2   385.218     3.943    1.6004   32.0072
60   ZERDA4    55     SOJA4  -198.506    10.831    1.0496  -62.2166
60   ZERDA4    64  RANCHHO4  -186.722   -14.775    1.0024  -71.5094

61    GTEC4   173     GTEC2  -143.581  -118.389    0.4205    8.4108
61    GTEC4    26  GTEC-IIG  -636.668    34.348    3.3174   66.3475
61    GTEC4    58   JHANOR4   206.829   104.582    0.1057   -4.5918
61    GTEC4    56    KASOR4   164.479     4.476    0.5201  -50.8640
61    GTEC4    64  RANCHHO4   408.940   -25.011    2.8652 -170.2762

62  AMRELI4   162   AMRELI2   359.919   149.622    1.4275   28.5489
62  AMRELI4    51     ASOJ4  -196.908   -90.671    2.0612 -123.3743
62  AMRELI4    53   JETPUR4   284.312    32.656    1.9681  -39.7012
62  AMRELI4    65  RAMPURA4  -674.153  -147.405    4.1568  -50.8983
62  AMRELI4    63   RAJKOT4   226.827     5.798    1.0499  -40.6935

63  RAJKOT4   180  RAJKO-II   325.779   105.788    1.1255   22.5104
63  RAJKOT4    57  CHORANI4  -252.611   -90.435    2.2029  -63.5015
63  RAJKOT4    53   JETPUR4   152.601    31.138    0.3889  -33.9968
63  RAJKOT4    62   AMRELI4  -225.777   -46.492    1.0499  -40.6935

64 RANCHHO4   187  RANCHHO2   399.547   191.091    1.7662   35.3239
64 RANCHHO4    59   DEHGAM4  -376.168     6.740    0.7941  -57.0117
64 RANCHHO4    60    ZERDA4   187.725   -56.734    1.0024  -71.5094
64 RANCHHO4    57  CHORANI4   174.121   -33.706    0.2302  -85.3146
64 RANCHHO4    55     SOJA4    20.841    37.871    0.0281  -27.0326
64 RANCHHO4    61     GTEC4  -406.075  -145.265    2.8652 -170.2762

65 RAMPURA4    25  RAMPURAG  -796.557    28.335    3.4167   68.3357
65 RAMPURA4    62   AMRELI4   678.309    96.507    4.1568  -50.8983
65 RAMPURA4    57  CHORANI4   118.247  -124.845    0.2674 -215.8809

66  PADGHE4    58   JHANOR4  -269.994    -0.001    4.2163 -127.7617

101   NASIK2  106  NAVSARI2    -0.000    -0.000    0.0829  -49.9426

102 PALITAN2  122   VARTEJ2   -18.540    -7.656    0.0279   -5.7450
102 PALITAN2  127  SAVARKU2    95.745   -17.285    1.1141   -3.5218
102 PALITAN2  184   GHOGHA2  -152.202   -21.059    1.1895   -9.8496

103 WAGODIA2  112  JAMBUVA2   -61.540    -9.667    0.1526   -3.0733
103 WAGODIA2  113     ASOJ2   -18.459   -45.332    0.1058   -4.2099

104 SARDGAD2  124   JETPUR2   -88.184   -20.786    0.9317   -3.6765
104 SARDGAD2  125   KESHOD2    33.187     2.786    0.1010   -5.7345

105 TARAPUR2  106  NAVSARI2   -29.184   -10.024    0.2107  -19.3035
105 TARAPUR2  107     VAPI2    29.184    10.025    0.1435   -9.9124

106 NAVSARI2  105  TARAPUR2    29.394    -9.279    0.2107  -19.3035
106 NAVSARI2  101    NASIK2     0.083   -49.943    0.0829  -49.9426
106 NAVSARI2  147    KAWAS2  -244.579   -25.890    2.2475   -1.4598
106 NAVSARI2  170  CHIKHLI2    38.001     6.701    0.0793   -3.9604
106 NAVSARI2  164   SACHIN2   -87.898   -10.590    0.1642   -6.3192

107    VAPI2  105  TARAPUR2   -29.040   -19.937    0.1435   -9.9124
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107      VAPI2  148 KAKRAPA2 -195.413   -38.534    3.8935 -12.5683
107      VAPI2  170 CHIKHLI2 -118.302   -21.989    1.1195  -0.5029
107      VAPI2  186  BHILAD2   42.757     4.458    0.0517  -8.1019

108  VALTHAN2  109 UKAITHE2  -86.082   -22.284    0.7695  -4.7971
108  VALTHAN2  148 KAKRAPA2 -167.282   -27.140    0.9708  -6.8247
108  VALTHAN2  147   KAWAS2 -231.637   -24.228    1.5808  -2.1223
108  VALTHAN2  144     KIM2   51.113    12.101    0.0954  -2.4026
108  VALTHAN2  156 ZAGADIA2   -2.795    -9.402    0.0034  -8.9703
108  VALTHAN2  182 BARDOLI2  -12.315    -9.331    0.0096  -3.9597
108  VALTHAN2  170 CHIKHLI2   88.998     7.284    0.3941 -14.4124

109  UKAITHE2    4 UKAITHEG -676.898    31.030    3.1006  62.0126
109  UKAITHE2   54 UKAITHE4   70.210   -56.111    0.1392   2.7840
109  UKAITHE2  108 VALTHAN2   86.851    17.487    0.7695  -4.7971
109  UKAITHE2  111 ACHHALI2  217.270   -19.278    1.9086 -27.2453
109  UKAITHE2  110 UKAIHYD2   66.406   -11.973    0.0213  -1.6801
109  UKAITHE2  182 BARDOLI2  236.163    38.849    1.9428 -17.2491

110  UKAIHYD2    3 UKAIHYDG -153.616   -18.144    0.3835   7.6709
110  UKAIHYD2  109 UKAITHE2  -66.385    10.292    0.0213  -1.6801
110  UKAIHYD2  111 ACHHALI2  140.004   -12.142    1.1796 -18.6474

111  ACHHALI2  527 ACHHALI1   34.713     0.822    0.0179   0.3585
111  ACHHALI2  109 UKAITHE2 -215.362    -7.967    1.9086 -27.2453
111  ACHHALI2  110 UKAIHYD2 -138.824    -6.505    1.1796 -18.6474
111  ACHHALI2  112 JAMBUVA2  189.473   -19.349    0.6174 -24.5884

112  JAMBUVA2  519 JAMBUVA1  114.271    57.745    0.3674   7.3484
112  JAMBUVA2  141 HALDARV2  -88.590    14.403    1.0043  -5.7164
112  JAMBUVA2  111 ACHHALI2 -188.855    -5.239    0.6174 -24.5884
112  JAMBUVA2  113    ASOJ2   43.761   -50.210    0.1513  -2.7817
112  JAMBUVA2  103 WAGODIA2   61.693     6.594    0.1526  -3.0733
112  JAMBUVA2  120 KARAMSA2  101.489   -38.089    0.4433 -11.7901
112  JAMBUVA2  156 ZAGADIA2  -43.768    14.796    0.2374  -7.8734

113     ASOJ2   51    ASOJ4 -271.252  -204.215    0.6638  13.2751
113     ASOJ2  521    ASOJ1  112.209    93.995    0.3028   6.0560
113     ASOJ2  112 JAMBUVA2  -43.609    47.429    0.1513  -2.7817
113     ASOJ2  103 WAGODIA2   18.564    41.122    0.1058  -4.2099
113     ASOJ2  120 KARAMSA2   70.045    11.093    0.1677 -12.2859
113     ASOJ2  116 WANAKBO2   -8.679   -12.584    0.0048 -22.1766
113     ASOJ2  114 CHANDRA2  122.719    23.159    0.3743  -7.6133

114  CHANDRA2  115  GODHRA2   22.346     5.771    0.0160 -10.2998
114  CHANDRA2  113    ASOJ2 -122.345   -30.772    0.3743  -7.6133

115   GODHRA2  117  KADANA2  -54.008   -21.598    0.1919 -21.5813
115   GODHRA2  114 CHANDRA2  -22.330   -16.070    0.0160 -10.2998
115   GODHRA2  196 SEVALIA2  -53.661   -10.332    0.1640  -4.0937

116  WANAKBO2    5 WANAKBIG -501.483   -24.842    2.5156  50.3117
116  WANAKBO2   52 WANAKBO4  -83.206   -73.894    0.2479   4.9578
116  WANAKBO2  113    ASOJ2    8.684    -9.593    0.0048 -22.1766
116  WANAKBO2  118 DHANSUR2  198.878    26.945    1.9247  -7.2233
116  WANAKBO2  145 KAPADWA2  278.156    35.542    2.3485   1.1111
116  WANAKBO2  196 SEVALIA2   98.970    45.840    0.1465  -0.3965

117   KADANA2    9  KADANAG -199.108   -11.545    0.8917  17.8348
117   KADANA2  115  GODHRA2   54.199     0.017    0.1919 -21.5813
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117	KADANA2	118	DHANSUR2	144.909	11.528	1.2630	-14.6108
118	DHANSUR2	116	WANAKBO2	-196.953	-34.168	1.9247	-7.2233
118	DHANSUR2	117	KADANA2	-143.646	-26.139	1.2630	-14.6108
118	DHANSUR2	139	HIMATNA2	250.597	31.306	1.7191	-0.4397
119	RANASAN2	504	RANASAN1	119.630	82.763	0.1734	3.4676
119	RANASAN2	145	KAPADWA2	-97.090	-1.227	0.3921	-12.2617
119	RANASAN2	120	KARAMSA2	-170.056	-11.616	1.5229	-12.5215
119	RANASAN2	130	GANDHIN2	240.936	-53.151	0.9450	-1.0254
119	RANASAN2	166	DEHGAM2	-93.412	-16.771	0.1392	-4.7240
120	KARAMSA2	502	KARAMSA1	132.629	74.350	0.5230	10.4600
120	KARAMSA2	112	JAMBUVA2	-101.045	26.299	0.4433	-11.7901
120	KARAMSA2	113	ASOJ2	-69.877	-23.379	0.1677	-12.2859
120	KARAMSA2	119	RANASAN2	171.579	-0.906	1.5229	-12.5215
120	KARAMSA2	169	KASOR2	-107.059	-126.705	0.2046	-4.9655
120	KARAMSA2	157	SALEJAD2	126.786	7.729	1.8767	-0.6702
120	KARAMSA2	173	GTEC2	-203.466	44.971	3.6919	-10.6176
120	KARAMSA2	184	GHOGHA2	50.457	-2.358	0.7300	-20.3372
121	LIMDI2	510	LIMDI1	119.631	72.040	0.3768	7.5360
121	LIMDI2	168	CHORANI2	-230.956	-84.376	0.1165	-0.1317
121	LIMDI2	177	CHOTILA2	111.325	12.326	1.4197	-2.4281
122	VARTEJ2	127	SAVARKU2	81.393	-12.459	0.9946	-7.7325
122	VARTEJ2	102	PALITAN2	18.568	1.911	0.0279	-5.7450
122	VARTEJ2	184	GHOGHA2	-249.958	-17.452	1.6023	0.0119
123	GONDAL2	513	GONDAL1	199.000	61.791	1.0601	21.2028
123	GONDAL2	163	RAJKOT2	-32.976	-16.882	0.1204	-6.5425
123	GONDAL2	124	JETPUR2	-85.314	-22.957	0.3475	-1.6318
123	GONDAL2	180	RAJKO-II	-80.707	-21.954	0.5956	-3.5445
124	JETPUR2	53	JETPUR4	-433.296	-112.412	1.2540	25.0807
124	JETPUR2	163	RAJKOT2	5.866	-7.073	0.0048	-9.1339
124	JETPUR2	123	GONDAL2	85.662	21.325	0.3475	-1.6318
124	JETPUR2	138	RANAVAV2	52.271	4.954	0.5134	-10.9124
124	JETPUR2	152	MOTIPAN2	2.070	7.523	0.0202	-9.6309
124	JETPUR2	127	SAVARKU2	-38.704	6.398	0.2580	-10.6959
124	JETPUR2	151	VISAVAD2	50.237	3.056	0.2401	-5.9441
124	JETPUR2	165	JAMNAGA2	-22.858	13.307	0.0738	-20.4426
124	JETPUR2	104	SARDGAD2	89.115	17.109	0.9317	-3.6765
124	JETPUR2	125	KESHOD2	99.646	18.818	1.3364	-2.8467
125	KESHOD2	104	SARDGAD2	-33.086	-8.520	0.1010	-5.7345
125	KESHOD2	124	JETPUR2	-98.310	-21.664	1.3364	-2.8467
125	KESHOD2	126	KODINAR2	21.402	8.185	0.0710	-7.6399
126	KODINAR2	153	DHOKADV2	-88.666	-7.175	0.7912	-2.8106
126	KODINAR2	125	KESHOD2	-21.331	-15.825	0.0710	-7.6399
127	SAVARKU2	124	JETPUR2	38.962	-17.094	0.2580	-10.6959
127	SAVARKU2	122	VARTEJ2	-80.398	4.727	0.9946	-7.7325
127	SAVARKU2	153	DHOKADV2	133.167	17.951	1.7119	1.5864
127	SAVARKU2	162	AMRELI2	-187.258	-48.330	1.1088	-3.6447
127	SAVARKU2	102	PALITAN2	-94.631	13.763	1.1141	-3.5218
127	SAVARKU2	181	MAHUVA2	65.163	13.985	0.1649	-10.0142
128	VIRAMGA2	168	CHORANI2	-48.974	-29.795	0.3401	-7.6026

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128 VIRAMGA2  187 RANCHHO2   -91.021   -20.204   0.5164   -2.3171

129 CHHATRA2  130 GANDHIN2 -207.341   -11.154   0.9328   -3.2495
129 CHHATRA2  187 RANCHHO2   -2.654   -16.846   0.0095   -3.3733

130 GANDHIN2    7 GANDHING -494.043  -129.968   1.7306   34.6123
130 GANDHIN2  119 RANASAN2 -239.991    52.125   0.9450   -1.0254
130 GANDHIN2  131    SOJA2  231.578    31.151   0.6933   -0.8925
130 GANDHIN2  129 CHHATRA2  208.274     7.904   0.9328   -3.2495
130 GANDHIN2  159   JAMLA2  294.192    38.789   0.7504   -7.7593

131    SOJA2   55    SOJA4 -532.117  -228.982   2.0777   41.5542
131    SOJA2  130 GANDHIN2 -230.884   -32.044   0.6933   -0.8925
131    SOJA2  136 PALANPU2  108.473    41.542   2.1740   -1.3984
131    SOJA2  160 KHERALU2  128.005    50.726   2.1436    1.9131
131    SOJA2  137 VIJAPUR2   61.834    40.231   0.1125   -5.9868
131    SOJA2  132 MEHSANA2  491.180   113.142   4.0384   -0.4495
131    SOJA2  159   JAMLA2 -193.347   -16.335   0.0925   -2.7918
131    SOJA2  179 SANTHAL2   63.077    14.005   0.2552   -3.7331
131    SOJA2  175  JOTANA2  103.768    17.692   0.6043   -1.4542

132 MEHSANA2  131    SOJA2 -487.141  -113.591   4.0384   -0.4495
132 MEHSANA2  134   ANJAR2   57.839   -11.471   1.4990  -29.6759
132 MEHSANA2  158 SANKHAR2   29.306     3.066   0.0953   -8.6630

133   DEODAR2 143   ZERDA2 -104.677    21.306   0.4717   -8.6691
133   DEODAR2 189 RADHANP2    9.683   -30.306   0.0286  -10.9717

134    ANJAR2 506   ANJAR1   94.200    42.497   0.2400    4.7994
134    ANJAR2 132 MEHSANA2  -56.340   -18.204   1.4990  -29.6759
134    ANJAR2 135 PANANDR2 -142.481   -57.319   3.1079  -30.1864
134    ANJAR2 190 CHITROD2  -35.362   -19.968   0.3276  -14.7202

135 PANANDR2    8 PANANDRG -171.208   -67.605   0.7802   15.6042
135 PANANDR2  134   ANJAR2  145.589    27.133   3.1079  -30.1864
135 PANANDR2  149 NAKHATR2   65.694     0.867   0.2548  -20.1396
135 PANANDR2  192 AKRIMOT2  -90.092     0.611   0.4007   -2.1160

136 PALANPU2  131    SOJA2 -106.299   -42.940   2.1740   -1.3984
136 PALANPU2  160 KHERALU2  -30.763   -15.638   0.1012   -5.8237
136 PALANPU2  143   ZERDA2  -12.931     1.579   0.0076   -9.8046

137 VIJAPUR2  131    SOJA2  -61.722   -46.218   0.1125   -5.9868
137 VIJAPUR2  139 HIMATNA2  -73.275    17.218   0.3319   -3.0532

138 RANAVAV2  515 RANAVAV1  110.006    22.271   0.3140    6.2802
138 RANAVAV2  124  JETPUR2  -51.758   -15.867   0.5134  -10.9124
138 RANAVAV2  152 MOTIPAN2  -58.253    -6.405   0.5397   -8.7527

139 HIMATNA2  118 DHANSUR2 -248.878   -31.745   1.7191   -0.4397
139 HIMATNA2  137 VIJAPUR2   73.607   -20.271   0.3319   -3.0532
139 HIMATNA2  195 MATHASU2   75.273    24.021   0.2736  -11.9796

140 DHRANGA2  168 CHORANI2 -259.980   -36.637   3.7960    0.8821
140 DHRANGA2  161   MORBI2  114.986    -1.362   0.7779  -14.5612

141 HALDARV2  148 KAKRAPA2   17.071   -18.227   0.0204  -20.4003
141 HALDARV2  147   KAWAS2   -1.110   -16.560   0.0018  -22.7168
141 HALDARV2  156 ZAGADIA2   97.116    -4.049   0.6153   -2.6384
141 HALDARV2  112 JAMBUVA2   89.594   -20.119   1.0043   -5.7164
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141 HALDARV2  155   JHANOR2 -267.891 -219.665   1.2580   2.4246
141 HALDARV2  172    WAGRA2   70.097   32.927   0.0980  -5.0734
141 HALDARV2  173     GTEC2 -284.879  105.701   0.6661   0.8328

142 ICHHAPU2  147    KAWAS2 -140.149    8.332   0.1322  -1.6352
142 ICHHAPU2  154    ESSAR2   65.152  -30.333   0.0580  -3.6517

143   ZERDA2   60    ZERDA4 -383.618   28.064   1.6004  32.0072
143   ZERDA2  136  PALANPU2   12.938  -11.384   0.0076  -9.8046
143   ZERDA2  171   THARAD2   85.365   -1.814   0.3720 -11.8139
143   ZERDA2  133   DEODAR2  105.148  -29.976   0.4717  -8.6691
143   ZERDA2  183  JANGRAL2   70.176    3.109   0.1801  -8.8912

144     KIM2  146    UTRAN2   29.660   25.877   0.0341  -6.4768
144     KIM2  108  VALTHAN2  -51.017  -14.503   0.0954  -2.4026
144     KIM2  156  ZAGADIA2  -59.733  -29.556   0.1500  -2.1381
144     KIM2  188    OLPAD2  -88.911  -21.815   0.2337  -8.4366

145 KAPADWA2  116  WANAKBO2 -275.807  -34.431   2.3485   1.1111
145 KAPADWA2  119  RANASAN2   97.482  -11.034   0.3921 -12.2617
145 KAPADWA2  167  KHANPUR2  118.325   22.465   0.5316  -9.6614

146   UTRAN2   14   UTRANEG -130.373  -41.645   0.6273  12.5453
146   UTRAN2  144      KIM2  -29.626  -32.354   0.0341  -6.4768

147   KAWAS2   15    KAWASG -621.435  -30.408   3.5641  71.2827
147   KAWAS2  106  NAVSARI2  246.827   24.430   2.2475  -1.4598
147   KAWAS2  108  VALTHAN2  233.218   22.106   1.5808  -2.1223
147   KAWAS2  141  HALDARV2    1.112   -6.157   0.0018 -22.7168
147   KAWAS2  142  ICHHAPU2  140.281   -9.968   0.1322  -1.6352

148 KAKRAPA2   16  KAKRAPAG -350.507  -44.106   1.4924  29.8479
148 KAKRAPA2  108  VALTHAN2  168.253   20.315   0.9708  -6.8247
148 KAKRAPA2  141  HALDARV2  -17.051   -2.173   0.0204 -20.4003
148 KAKRAPA2  107     VAPI2  199.307   25.965   3.8935 -12.5683

149 NAKHATR2  135  PANANDR2  -65.439  -21.006   0.2548 -20.1396
149 NAKHATR2  150  NANIKHA2  113.111   15.610   0.6683 -12.6001
149 NAKHATR2  192  AKRIMOT2 -107.673  -17.602   0.9127 -21.2016

150 NANIKHA2  149  NAKHATR2 -112.443  -28.210   0.6683 -12.6001
150 NANIKHA2  190  CHITROD2   22.461  -10.787   0.0826 -41.1812

151 VISAVAD2  124   JETPUR2  -49.997   -9.000   0.2401  -5.9441

152 MOTIPAN2  124   JETPUR2   -2.050  -17.154   0.0202  -9.6309
152 MOTIPAN2  138  RANAVAV2   58.792   -2.348   0.5397  -8.7527
152 MOTIPAN2  193  MOTIKHA2 -121.738  -12.497   0.8675 -13.2836

153 DHOKADV2  127  SAVARKU2 -131.455  -16.364   1.7119   1.5864
153 DHOKADV2  126  KODINAR2   89.457    4.365   0.7912  -2.8106

154   ESSAR2   17    ESSARG -309.090 -101.603   0.9101  18.2021
154   ESSAR2  142  ICHHAPU2  -65.094   26.681   0.0580  -3.6517
154   ESSAR2  164   SACHIN2  219.336   42.765   1.2747  -2.5033
154   ESSAR2  188    OLPAD2  154.847   32.157   0.7025  -6.2233

155  JHANOR2   58   JHANOR4  307.863 -250.039   0.9234  18.4675
155  JHANOR2   10   JHANORG -577.016   27.947   2.9823  59.6457
155  JHANOR2  141  HALDARV2  269.149  222.090   1.2580   2.4246
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156	ZAGADIA2	144	KIM2	59.883	27.418	0.1500	-2.1381
156	ZAGADIA2	141	HALDARV2	-96.500	1.411	0.6153	-2.6384
156	ZAGADIA2	178	MANGROL2	-60.186	-27.590	0.1164	-9.1575
156	ZAGADIA2	108	VALTHAN2	2.798	0.432	0.0034	-8.9703
156	ZAGADIA2	112	JAMBUVA2	44.006	-22.670	0.2374	-7.8734
157	SALEJAD2	120	KARAMSA2	-124.909	-8.399	1.8767	-0.6702
157	SALEJAD2	168	CHORANI2	24.911	-36.600	0.1950	-9.0700
158	SANKHAR2	132	MEHSANA2	-29.211	-11.729	0.0953	-8.6630
158	SANKHAR2	175	JOTANA2	-157.991	-50.187	0.9193	-5.9388
158	SANKHAR2	189	RADHANP2	77.205	14.917	0.8675	-5.8147
159	JAMLA2	130	GANDHIN2	-293.442	-46.548	0.7504	-7.7593
159	JAMLA2	131	SOJA2	193.440	13.544	0.0925	-2.7918
160	KHERALU2	131	SOJA2	-125.861	-48.813	2.1436	1.9131
160	KHERALU2	136	PALANPU2	30.864	9.814	0.1012	-5.8237
161	MORBI2	140	DHRANGA2	-114.208	-13.199	0.7779	-14.5612
161	MORBI2	180	RAJKO-II	-38.525	-23.742	0.1011	-17.9225
161	MORBI2	190	CHITROD2	27.741	-2.057	0.1338	-12.3054
162	AMRELI2	62	AMRELI4	-358.492	-121.073	1.4275	28.5489
162	AMRELI2	176	DHASA2	60.128	24.388	0.1304	-8.6125
162	AMRELI2	127	SAVARKU2	188.367	44.686	1.1088	-3.6447
163	RAJKOT2	123	GONDAL2	33.096	10.340	0.1204	-6.5425
163	RAJKOT2	124	JETPUR2	-5.861	-2.061	0.0048	-9.1339
163	RAJKOT2	193	MOTIKHA2	-68.137	-1.648	0.5380	-31.3776
163	RAJKOT2	180	RAJKO-II	-149.086	-39.628	0.2049	-4.9255
164	SACHIN2	154	ESSAR2	-218.061	-45.268	1.2747	-2.5033
164	SACHIN2	106	NAVSARI2	88.062	4.271	0.1642	-6.3192
165	JAMNAGA2	529	JAMNAGA1	52.761	5.672	0.1369	2.7379
165	JAMNAGA2	124	JETPUR2	22.931	-33.749	0.0738	-20.4426
165	JAMNAGA2	193	MOTIKHA2	-205.692	-14.922	1.1040	-2.3213
166	DEHGAM2	59	DEHGAM4	-276.295	-159.336	0.9067	18.1349
166	DEHGAM2	119	RANASAN2	93.551	12.047	0.1392	-4.7240
166	DEHGAM2	167	KHANPUR2	182.740	147.285	0.5391	-0.5875
167	KHANPUR2	166	DEHGAM2	-182.201	-147.872	0.5391	-0.5875
167	KHANPUR2	145	KAPADWA2	-117.793	-32.127	0.5316	-9.6614
168	CHORANI2	57	CHORANI4	-519.442	-171.467	[illegible]	35.9270
168	CHORANI2	128	VIRAMGA2	49.314	22.192	0.3401	-7.6026
168	CHORANI2	140	DHRANGA2	263.776	37.519	3.7960	0.8821
168	CHORANI2	121	LIMDI2	231.072	84.244	0.1165	-0.1317
168	CHORANI2	157	SALEJAD2	-24.716	27.530	0.1950	-9.0700
169	KASOR2	56	KASOR4	-131.814	-153.274	0.3548	7.0968
169	KASOR2	120	KARAMSA2	107.264	121.740	0.2046	-4.9651
169	KASOR2	174	MOBHA2	-32.830	28.711	0.0926	-13.6780
169	KASOR2	184	GHOGHA2	57.376	2.822	0.8929	-17.9975
170	CHIKHLI2	106	NAVSARI2	-37.921	-10.661	[illegible]	-3.9604
170	CHIKHLI2	107	VAPI2	119.422	21.486	[illegible]	-0.5029

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 170 CHIKHLI2   108 VALTHAN2  -88.604   -21.696    0.3941 -14.4124
 170 CHIKHLI2   182 BARDOLI2 -151.125   -35.952    0.7772  -7.0618
 170 CHIKHLI2   186  BHILAD2   88.228    13.825    0.9343  -4.6149

 171  THARAD2   143    ZERDA2  -84.993   -10.000    0.3720 -11.8139

 172   WAGRA2   141 HALDARV2  -69.999   -38.000    0.0980  -5.0734

 173    GTEC2    18  GTEC-IG -636.708    33.656    3.2827  65.6554
 173    GTEC2    61    GTEC4  144.002   126.799    0.4205   8.4108
 173    GTEC2   141 HALDARV2  285.545  -104.868    0.6661   0.8328
 173    GTEC2   120 KARAMSA2  207.158   -55.589    3.6919 -10.6176

 174   MOBHA2   178 MANGROL2 -102.922    14.390    0.8994 -23.6532
 174   MOBHA2   169   KASOR2   32.923   -42.389    0.0926 -13.6780

 175  JOTANA2   131    SOJA2 -103.163   -19.146    0.6043  -1.4542
 175  JOTANA2   179 SANTHAL2  -32.764    -2.868    0.0594  -4.1301
 175  JOTANA2   158 SANKHAR2  158.910    44.248    0.9193  -5.9388
 175  JOTANA2   187 RANCHHO2 -122.981   -60.231    0.6016  -7.8220

 176   DHASA2   162  AMRELI2  -59.998   -33.000    0.1304  -8.6125

 177 CHOTILA2   121   LIMDI2 -109.906   -14.755    1.4197  -2.4281
 177 CHOTILA2   180 RAJKO-II   64.908    -5.245    0.3516  -4.8976

 178 MANGROL2    20 MANGROLG -199.196     6.035    0.8017  16.0350
 178 MANGROL2   156 ZAGADIA2   60.302    18.433    0.1164  -9.1575
 178 MANGROL2   174   MOBHA2  103.822   -38.043    0.8994 -23.6532
 178 MANGROL2   182 BARDOLI2   35.072    13.573    0.0659 -13.5902

 179 SANTHAL2   131    SOJA2  -62.822   -17.738    0.2552  -3.7331
 179 SANTHAL2   175  JOTANA2   32.823    -1.262    0.0594  -4.1301

 180 RAJKO-II    63  RAJKOT4 -324.653   -83.278    1.1255  22.5104
 180 RAJKO-II   161   MORBI2   38.627     5.820    0.1011 -17.9225
 180 RAJKO-II   163  RAJKOT2  149.290    34.703    0.2049  -4.9255
 180 RAJKO-II   123  GONDAL2   81.303    18.410    0.5956  -3.5445
 180 RAJKO-II   177 CHOTILA2  -64.556     0.348    0.3516  -4.8976

 181  MAHUVA2   127 SAVARKU2  -64.998   -23.999    0.1649 -10.0142

 182 BARDOLI2   109 UKAITHE2 -234.220   -56.098    1.9428 -17.2491
 182 BARDOLI2   108 VALTHAN2   12.324     5.371    0.0096  -3.9597
 182 BARDOLI2   170 CHIKHLI2  151.902    28.890    0.7772  -7.0618
 182 BARDOLI2   178 MANGROL2  -35.006   -27.164    0.0659 -13.5902

 183 JANGRAL2   143    ZERDA2  -69.996   -12.000    0.1801  -8.8912

 184   GHOGHA2   21  GHOGHAG -298.739    10.124    1.2561  25.1229
 184   GHOGHA2  120 KARAMSA2  -49.727   -17.979    0.7300 -20.3372
 184   GHOGHA2  122  VARTEJ2  251.560    17.464    1.6023   0.0119
 184   GHOGHA2  102 PALITAN2  153.392    11.210    1.1895  -9.8496
 184   GHOGHA2  169   KASOR2  -56.483   -20.819    0.8929 -17.9975

 186   BHILAD2  107    VAPI2  -42.705   -12.560    0.0517  -8.1019
 186   BHILAD2  170 CHIKHLI2  -87.294   -18.440    0.9343  -4.6149

 187 RANCHHO2    64 RANCHHO4 -397.781  -155.767    1.7662  35.3239
 187 RANCHHO2   129 CHHATRA2    2.664    13.473    0.0095  -3.3733
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187 RANCHHO2   128 VIRAMGA2   91.537    17.887     0.5164   -2.3171
187 RANCHHO2   175  JOTANA2  123.583    52.408     0.6016   -7.8220

188   OLPAD2   154   ESSAR2 -154.144   -38.380     0.7025   -6.2233
188   OLPAD2   144     KIM2   89.144    13.378     0.2337   -8.4366

189 RADHANP2   158 SANKHAR2  -76.338   -20.732     0.8675   -5.8147
189 RADHANP2   133  DEODAR2   -9.654    19.335     0.0286  -10.9717
189 RADHANP2   190 CHITROD2   30.990   -31.602     0.2864  -11.2058

190 CHITROD2   189 RADHANP2  -30.703    20.396     0.2864  -11.2058
190 CHITROD2   134   ANJAR2   35.690     5.248     0.3276  -14.7202
190 CHITROD2   150 NANIKHA2  -22.379   -30.394     0.0826  -41.1812
190 CHITROD2   161   MORBI2  -27.607   -10.249     0.1338  -12.3054

192 AKRIMOT2    23 AKRIMOTG -199.104     6.330     0.8165   16.3292
192 AKRIMOT2   135 PANANDR2   90.493    -2.727     0.4007   -2.1160
192 AKRIMOT2   149 NAKHATR2  108.586    -3.600     0.9127  -21.2016

193 MOTIKHA2    24 MOTIKHAG -398.076    17.915     1.8957   37.9140
193 MOTIKHA2   165 JAMNAGA2  206.796    12.601     1.1040   -2.3213
193 MOTIKHA2   163  RAJKOT2   68.675   -29.729     0.5380  -31.3776
193 MOTIKHA2   152 MOTIPAN2  122.606    -0.787     0.8675  -13.2836

195 MATHASU2   139 HIMATNA2  -74.999   -36.000     0.2736  -11.9796

196 SEVALIA2   116 WANAKBO2  -98.824   -46.236     0.1465   -0.3965
196 SEVALIA2   115  GODHRA2   53.825     6.239     0.1640   -4.0937

501 DHUVARA1     1 DHUVARAG -447.154   -47.297     1.8445   36.8916
501 DHUVARA1   518   GOTRI1   22.316    22.562     0.1873   -4.2784
501 DHUVARA1   502 KARAMSA1   83.989    16.057     1.0962   -1.0530
501 DHUVARA1   503   VATWA1   95.001    15.976     1.8355   -0.1538
501 DHUVARA1   510   LIMDI1   88.095   -15.220     3.2676   -2.3176
501 DHUVARA1   511 DHANDHU1  102.387    10.244     7.7172   17.9896
501 DHUVARA1   514  RAJKOT1   55.370    -2.319     5.5884    4.2426

502 KARAMSA1   120 KARAMSA2 -132.106   -63.890     0.5230   10.4600
502 KARAMSA1   501 DHUVARA1  -82.893   -17.110     1.0962   -1.0530

503   VATWA1   501 DHUVARA1  -93.165   -16.130     1.8355   -0.1538
503   VATWA1   504 RANASAN1  -56.834   -46.870     0.5312   -1.1012

504 RANASAN1   119 RANASAN2 -119.457   -79.295     0.1734    3.4676
504 RANASAN1   503   VATWA1   57.365    45.769     0.5312   -1.1012
504 RANASAN1   505 SABARMA1 -117.922   -16.472     0.6753    0.6314

505 SABARMA1   517  AECOMP1 -118.653   -17.162     0.0135   -0.0156
505 SABARMA1   504 RANASAN1  118.596    17.103     0.6753    0.6314

506   ANJAR1   134   ANJAR2  -93.960   -37.697     0.2400    4.7994
506   ANJAR1   507 WANKANE1  -11.006    -1.296     0.1726   -7.0147

507 WANKANE1   510   LIMDI1 -100.174    -7.222     3.9094    2.3831
507 WANKANE1   508 NAGHEDI1   -3.295   -12.062     0.0914   -4.9814
507 WANKANE1   506   ANJAR1   11.179    -5.718     0.1726   -7.0147
507 WANKANE1   529 JAMNAGA1   -7.705   -12.995     0.1432   -4.4051

508 NAGHEDI1   509   SIKKA1  -31.380   -24.581     0.2006   -2.8112
508 NAGHEDI1   507 WANKANE1    3.386     7.081     0.0914   -4.9814
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508 NAGHEDI1  529 JAMNAGA1   -47.003    -3.500    0.1571    0.0078

509   SIKKA1    2   SIKKAG -191.034   -74.659    0.9602   19.2041
509   SIKKA1  508 NAGHEDI1   31.581    21.769    0.2006   -2.8112
509   SIKKA1  529 JAMNAGA1    2.407     6.962    0.0245   -2.2013
509   SIKKA1  530 JAMKHAM1   45.147    14.379    0.6946    0.0845
509   SIKKA1  516  BHATIA1   61.890    13.552    1.1003   -3.6366

510   LIMDI1  121   LIMDI2 -119.254   -64.504    0.3768    7.5360
510   LIMDI1  501 DHUVARA1  -84.827    12.903    3.2676   -2.3176
510   LIMDI1  507 WANKANE1  104.083     9.605    3.9094    2.3831

511 DHANDHU1  501 DHUVARA1  -94.670     7.745    7.7172   17.9896
511 DHANDHU1  512  PALIAD1   54.673    -7.745    1.5731    1.9352

512  PALIAD1  511 DHANDHU1  -53.100     9.681    1.5731    1.9352
512  PALIAD1  513  GONDAL1  -16.902   -11.681    0.2905   -3.1229

513  GONDAL1  123  GONDAL2 -197.940   -40.588    1.0601   21.2028
513  GONDAL1  512  PALIAD1   17.192     8.558    0.2905   -3.1229
513  GONDAL1  514  RAJKOT1   35.630     9.067    0.4136   -0.4956
513  GONDAL1  515 RANAVAV1   -4.874    -4.036    0.0286   -6.8398

514  RAJKOT1  501 DHUVARA1  -49.782     6.562    5.5884    4.2426
514  RAJKOT1  513  GONDAL1  -35.216    -9.562    0.4136   -0.4956

515 RANAVAV1  138 RANAVAV2 -109.692   -15.991    0.3140    6.2802
515 RANAVAV1  513  GONDAL1    4.902    -2.803    0.0286   -6.8398
515 RANAVAV1  516  BHATIA1   -5.195     0.795    0.0240   -4.0157

516  BHATIA1  515 RANAVAV1    5.219    -4.810    0.0240   -4.0157
516  BHATIA1  530 JAMKHAM1   -9.425     0.000    0.0268   -1.7047
516  BHATIA1  509   SIKKA1  -60.790   -17.189    1.1003   -3.6366

517  AECOMP1   11 AECOMPDG -668.681   -18.095    3.3217   66.4332
517  AECOMP1  505 SABARMA1  118.671    17.147    0.0135   -0.0156

518   GOTRI1  520 FERTNGR1  -66.205    21.980    0.1464   -0.3927
518   GOTRI1  519 JAMBUVA1  -51.666   -22.139    0.0328   -3.4433
518   GOTRI1  501 DHUVARA1  -22.129   -26.840    0.1873   -4.2784

519 JAMBUVA1  112 JAMBUVA2 -113.903   -50.397    0.3674    7.3484
519 JAMBUVA1  524 MIYAGAM1  -33.969    -6.446    0.2652   -0.7854
519 JAMBUVA1  523 JAWAHAR1  -23.826     8.147    0.0923   -3.5813
519 JAMBUVA1  518   GOTRI1   51.699    18.696    0.0328   -3.4433

520 FERTNGR1  523 JAWAHAR1  -85.502    18.361    0.2001   -0.1524
520 FERTNGR1  518   GOTRI1   66.352   -22.373    0.1464   -0.3927
520 FERTNGR1  521    ASOJ1  -60.850   -45.988    0.2563   -0.4830

521    ASOJ1  113    ASOJ2 -111.906   -87.939    0.3028    6.0560
521    ASOJ1  522 NANDESA1  -24.202    35.433    0.1346   -1.6104
521    ASOJ1  520 FERTNGR1   61.106    45.505    0.2563   -0.4830

522 NANDESA1  521    ASOJ1   24.337   -37.044    0.1346   -1.6104
522 NANDESA1  528   GIPCL1 -104.339   -12.977    0.0159   -0.4507

523 JAWAHAR1  519 JAMBUVA1   23.918   -11.729    0.0923   -3.5813
523 JAWAHAR1  528   GIPCL1 -189.619   -19.763    0.2978   -1.3281
523 JAWAHAR1  520 FERTNGR1   85.702   -18.514    0.2001   -0.1524
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 524 MIYAGAM1  519 JAMBUVA1   34.234     5.660   0.2652  -0.7854
 524 MIYAGAM1  525 BHARUCH1  -34.234    -5.660   0.2702  -0.8719

 525 BHARUCH1  524 MIYAGAM1   34.504     4.788   0.2702  -0.8719
 525 BHARUCH1  526 ANKLESH1  -34.504    -4.788   0.0434  -0.9594

 526 ANKLESH1  527 ACHHALI1  -34.547    -3.831   0.1484  -3.3669
 526 ANKLESH1  525 BHARUCH1   34.547     3.829   0.0434  -0.9594

 527 ACHHALI1  111 ACHHALI2  -34.695    -0.464   0.0179   0.3585
 527 ACHHALI1  526 ANKLESH1   34.695     0.464   0.1484  -3.3669

 528   GIPCL1  13   GIPCLG -294.278   -30.944   1.7208  34.4147
 528   GIPCL1  523 JAWAHAR1  189.917    18.435   0.2978  -1.3281
 528   GIPCL1  522 NANDESA1  104.355    12.526   0.0159  -0.4507

 529 JAMNAGA1  165 JAMNAGA2  -52.624    -2.934   0.1369   2.7379
 529 JAMNAGA1  507 WANKANE1    7.848     8.590   0.1432  -4.4051
 529 JAMNAGA1  509   SIKKA1   -2.383    -9.163   0.0245  -2.2013
 529 JAMNAGA1  508 NAGHEDI1   47.160     3.508   0.1571   0.0078

 530 JAMKHAM1  516  BHATIA1    9.452    -1.705   0.0268  -1.7047
 530 JAMKHAM1  509   SIKKA1  -44.453   -14.295   0.6946   0.0845
-----------------------------------------------------------------------------
NEW SYSTEM FREQUENCY FOR ISLAND 1          :     50.000 Hzs

TOTAL REAL POWER GENERATION    :  11079.774 MW
TOTAL REACT. POWER GENERATION  :   1515.543 MVAR

TOTAL SHUNT REACTOR INJECTION  :     -0.000 MW
TOTAL SHUNT REACTOR INJECTION  :     -0.000 MVAR

TOTAL SHUNT CAPACIT.INJECTION  :     -0.000 MW
TOTAL SHUNT CAPACIT.INJECTION  :     -0.000 MVAR

TOTAL REAL POWER LOAD           :  10847.000 MW
TOTAL REACTIVE POWER LOAD       :   8055.000 MVAR
TOTAL COMPENSATION AT LOADS     :   4440.999 MVAR
TOTAL HVDC REACTIVE POWER       :      0.000 MVAR

TOTAL REAL POWER LOSS (AC+DC)   :    232.626 MW (   232.626+      0.000)
PERCENTAGE REAL  LOSS (AC+DC)   :      2.100
TOTAL REACTIVE POWER  LOSS      :  -2098.413 MVAR

---------------------------------------------------------------------------
Zone wise distribution
Description           Zone # 1   Zone # 2   Zone # 3   Zone # 4   Zone # 5

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MW generation      4312.0003  3536.0001  1167.7742  1692.0000   372.0000

MVAR generation     512.1361   492.2265   249.1079   168.8633    93.2091

MW load            2780.0001  1754.9997  3105.0001  2762.0003   445.0000

MVAR load          1698.0000  1284.0000  2469.0002  2225.9998   378.0000

MVAR compensation   865.0000   260.0000  1700.0000  1431.0000   19[illegible]
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 loss               61.0907    70.6552    35.5532    57.8908     7.4361

AR loss           -527.5415  -788.7617  -243.9019  -440.5015   -97.7068

AR - inductive      0.0000     0.0000     0.0000     0.0000     0.0000

AR - capacitive     0.0000     0.0000     0.0000     0.0000     0.0000

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ne wise export(+ve)/import(-ve)
ne #    1 MW & MVAR        2 MW & MVAR        3 MW & MVAR        4 MW & MVAR
        5 MW & MVAR
---- -------- -------- -------- -------- -------- -------- -------- --------
   1       -----        1064.81    61.43   406.07   145.27     0.00     0.00
         0.00     0.00

   2 -1064.81   -61.43       -----         1732.90  170.00  1042.20   148.41
         0.00     0.00

   3  -406.07  -145.27 -1732.90  -170.00       -----           96.84    31.47
        69.32     7.78

   4     0.00     0.00 -1042.20  -148.41   -96.84   -31.47       -----
        11.18    -5.72

   5     0.00     0.00     0.00     0.00   -69.32    -7.78   -11.18     5.72
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e and Time : Thu Dec  4 14:34:50 1997
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